TOOELE
ARMY
DEPOT

FINAL

SOLIDIFICATION TREATABILITY STUDY REPORT TOOELE ARMY DEPOT TOOELE, UTAH

Contract No. DACW05-00-D-0010
Delivery Order No. 1

Prepared for:

U. S. Army Engineer District, Sacramento
1325 J Street
Sacramento, California 95814

Prepared by:

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Bethesda, Maryland 20814

JUNE 2002

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Note: The reverse side of color figures are intentionally blank and are presented in consecutive order.

TABLES

ACRONYMS AND ABBREVIATIONS

bgs	Below ground surface
BDAT	Best demonstrated available technology
BRAC	Base Realignment and Closure
CAMU	Corrective Action Management Unit
CAO	Corrective action objective
CKD	Cement kiln dust
cm/sec	Centimeter per second
CMS	Corrective Measures Study
COC	Contaminant of concern
DCD	Deseret Chemical Depot
2,4-DNT	2,4-Dinitrotoluene
EPA	U.S. Environmental Protection Agency
FA	Fly ash
FRG	Final remediation goal
FS	Feasibility Study
ft^2	Square foot
IDW	Investigative derived waste
LDR	Land disposal restrictions
LKD	Lime kiln dust
µg/g	Microgram per gram
mg/L	Milligram per liter
PCA	Portland Cement Association
PPE	Personal protective equipment
psi	Pound per square inch
QC	Quality control
RAWP	Remedial Action Work Plan
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RI	Remedial Investigation

ACRONYMS AND ABBREVIATIONS (cont'd)

ROD	Record of Decision
SAIC	Science Applications International Corporation
SPLP	Synthetic Precipitation Leaching Procedure
S/S	Solidification/stabilization
SWMU	Solid waste management unit
SVOC	Semivolatile organic compound
TEAD	Tooele Army Depot
TEAD-N	Tooele Army Depot - North Area
TEAD-S	Tooele Army Depot - South Area
TECA	Tooele Chemical Activity
TSWP	Treatability Study Work Plan
UCS	Unconfined compressive strength
UDEQ	Utah Department of Environmental Quality
USACE	U.S. Army Corps of Engineers
UXO	Unexploded ordnance
yd^3	Cubic yard

1.0 INTRODUCTION

This document is the Solidification Treatability Study Report for the Old Burn Area (Solid Waste Management Unit (SWMU) 6), the Small Arms Firing Range (SWMU 8), and the Skeet Range (SWMU 57), Tooele Army Depot (TEAD), Tooele, Utah. It has been prepared for the U.S. Army Corps of Engineers (USACE), Sacramento District, under the requirements of Contract No. DACW05-00-D-0010.

1.1 PURPOSE AND OBJECTIVE OF TREATABILITY STUDY

The purpose of this report is to document the methods and procedures used in conducting the solidification treatability study at SWMUs 6, 8, and 57 in June 2001. All work was conducted in accordance with the *Solidification Treatability Study Work Plan (TSWP)*, (URS, 2001). As stated in the *Final Feasibility Study (FS) Report, Operable Units 4 and 8, Tooele Army Depot, Tooele, Utah* (Dames & Moore, 1999) and the *Revised Final Record of Decision (ROD) Operable Unit 8, Tooele Army Depot, Tooele, Utah* (Dames & Moore, 2000), solidification/stabilization (S/S) is the preferred treatment alternative for lead at SWMUs 6 and 8. This study includes SWMU 57, a Group C SWMU, because lead-contaminated soil at the Skeet Range is a candidate for treatment using S/S.

Before conducting the treatability study, the TSWP and site-specific performance criteria were subject to review, comment, and concurrence by the EPA, the Utah Department of Environmental Quality (UDEQ), and USACE. The TSWP was approved by regulatory agencies prior to commencing field and testing activities. Information gathered during the treatability study and presented here will be used in developing Remedial Action Work Plans (RAWPs) for the full-scale S/S remediation at SWMUs 6 and 8 only. The SWMU 57 corrective measures plan will be handled separately.

The objective of the treatability study was to determine the optimal mixture of additives to achieve solidification treatment standards for lead at SWMUs 6, 8, and 57 using a phased approach. Each phase of the treatability study characterized a reagent/dosage mixture until the mixture that best met performance criteria was identified. Performance criteria were measured via physical and chemical tests in the laboratory.

The ROD (Dames & Moore, 2000) states that treating the soil at SWMUs 6 and 8 by S/S will immobilize contaminants and protect groundwater at the final disposal site. Land disposal restriction (LDR) treatment standards do not apply if treated soil is placed in a corrective action management unit (CAMU). (LDRs do apply if the treated soil is disposed of at the SWMU.) This treatability study report identifies a mixture that is stable and protective of groundwater quality at the CAMU disposal location.

The three main drivers for performing S/S on the lead-contaminated soil are to mitigate the:

- bioavailability of lead-contaminated soil to human receptors,
- bioavailability of lead-contaminated soil to ecological receptors, and
- potential future lead contamination of groundwater.

S/S will physically and chemically eliminate the exposure to lead-contaminated soil at the CAMU. The site-specific performance criteria identified in the TSWP establish encapsulation via physical and chemical criteria that are measured in the laboratory. The physical process of S/S eliminates the exposure pathway of lead-contaminated soil to human and ecological receptors. In addition, chemical and physical criteria are necessary to prevent lead contamination in the groundwater.

1.2 BACKGROUND INFORMATION

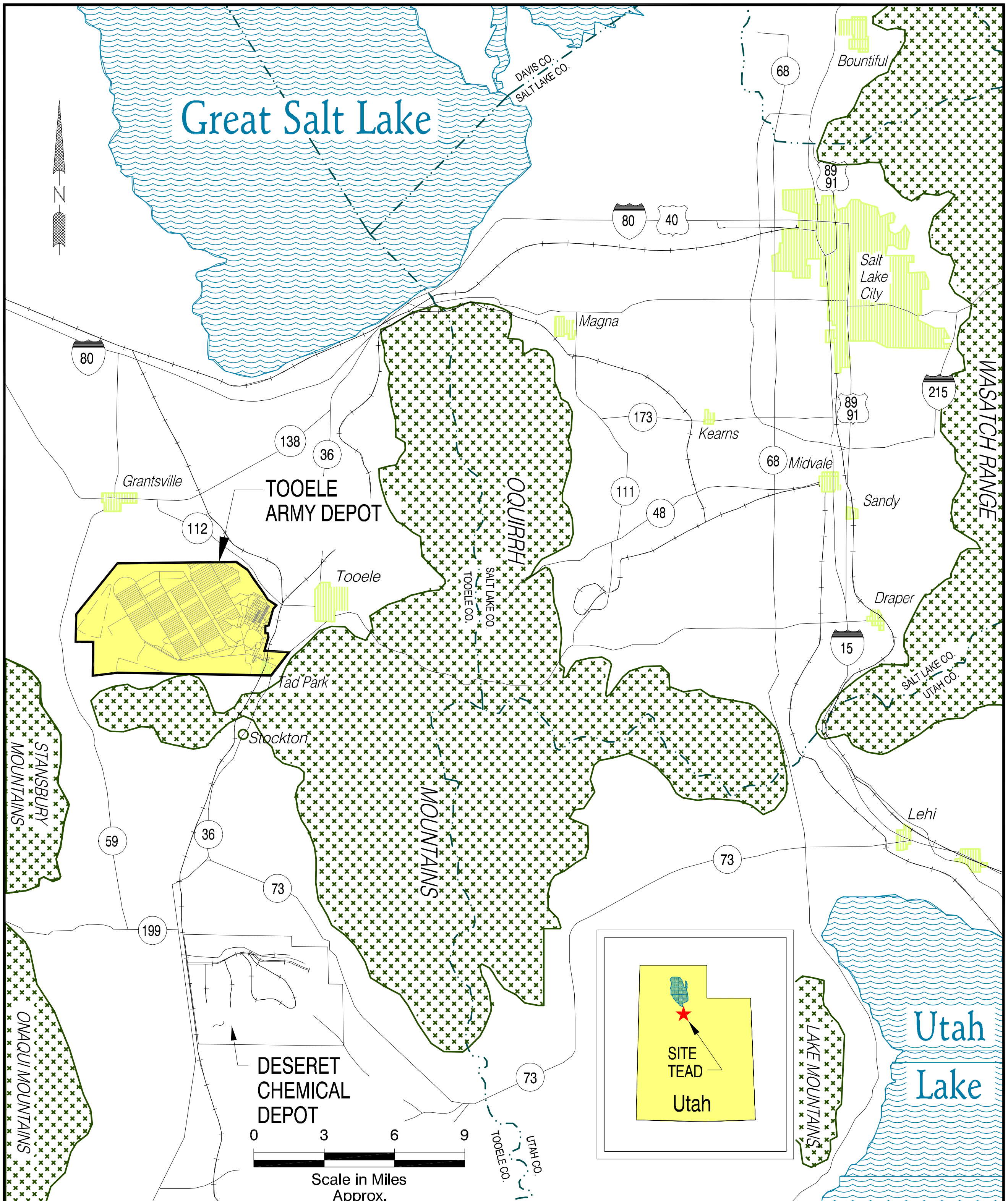
The Remedial Investigation (RI) Report (Rust E&I, 1997), FS Report (Dames & Moore, 1999), and the RODs (Dames & Moore, 2000) present detailed information on TEAD and SWMUs 6 and 8. Information about SWMU 57 is detailed in the *RCRA Facility Investigation (RFI) Report for Group C Suspected Releases SWMUs* (SAIC, 1997); the *Corrective Measures Study (CMS) Work Plan, Group C SWMUs 2000*; and the *CMS Report Group C SWMUs* (Dames & Moore, 2001). Sections 1.2.1 through 1.2.8 of the TSWP summarize background information concerning TEAD, including its location, physical characteristics, topography, groundwater, surface water, and the base history.

1.2.1 TEAD Location

TEAD is located in Tooele Valley, Tooele County, Utah, immediately west of the City of Tooele and approximately 35 miles southwest of Salt Lake City (Figure 1-1). The installation covers 23,610 acres; 1,700 acres (from an original 25,173) were transferred to the Tooele City Redevelopment Agency in December 1998 under the Base Realignment and Closure (BRAC) Program. SWMU 57 is part of the property that was transferred. The surrounding area is largely undeveloped, with the exception of Tooele, Grantsville and Stockton. As a result of past operations at TEAD and environmental investigations since the late 1970s, 57 known or suspected SWMUs have been identified.

1.2.2 History, Present Mission and Future Use

TEAD was originally established in 1942 as the Tooele Ordnance Depot by the U.S. Army Ordnance Department. It was redesignated as TEAD-North Area (TEAD-N) in August 1962. TEAD-South Area (TEAD-S) came under the command of TEAD-N later in 1962. Both the North and South Areas of TEAD have been major ammunition storage and equipment maintenance installations that support other U.S. Army facilities throughout the western United States. In 1996, TEAD-N and TEAD-S were designated as TEAD and Tooele Chemical Activity (TECA), respectively. In October 1996, TECA was redesignated as Deseret Chemical Depot (DCD).



SOURCE: RUST E&I, 1995

FIGURE 1-1
LOCATION MAP OF
TOOELE ARMY DEPOT
AND VICINITY

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The current missions of TEAD are:

- To receive, store, issue, maintain, and dispose of munitions
- To provide installation support to attached organizations
- To operate other facilities as assigned.

The mission of maintaining and repairing equipment was discontinued in 1995.

Developed features at TEAD include igloos, magazines, administrative buildings, an industrial maintenance area, military and civilian housing, roads, and vehicle storage hardstands and other allied infrastructure. In 1993, TEAD was placed on the list of facilities scheduled for realignment under the BRAC Program; the vehicle and equipment maintenance and storage functions were transferred to the Red River Army Depot, Texas. TEAD continues to store conventional ammunition.

Of the SWMUs discussed in this report, SWMU 57 is located within the Administration Area, which was transferred under BRAC in December 1998 (Figure 1-2). The TEAD Conversion and Reuse Plan (Tooele County Economic Development Corporation, 1995) identifies the primary land use planned for the SWMU 57 area as residential. SWMUs 6 and 8 are located in the non-BRAC parcel, which will continue to be used for military purposes. The CAMU is located in the Sanitary Landfill and Pesticide Disposal Area (SWMU 12/15) which remains under military control (Figure 1-3).

1.3 STATEMENT OF PROBLEM

As stated in the FS and RODs for Operable Units 4 and 8, S/S is the preferred treatment alternative for lead at SWMUs 6 and 8. Because lead-contaminated soil at SWMU 57, a Group C SWMU, could also be treated using S/S, this site is included in the treatability study. The FS and Group C CMS present the soil cleanup goals that are required to protect human health and the environment. Based on those values and chemical data, the areas of contamination that require remediation are determined.

Soil cleanup goals are calculated based on exposure and toxicity data. They represent the maximum concentrations allowable for a given exposure scenario to prevent an unacceptable health risk. They are based on assumed exposure to surface soil by Depot workers (SWMUs 6 and 8) or residents (SWMU 57). The lead cleanup goal is calculated using a model that estimates blood lead levels in the exposed population. The goals for metals other than lead are based on assumed exposure via incidental ingestion and dermal absorption. This is the approach used in the calculation of cleanup goals in the FS and Group C CMS as approved by regulatory reviewers. The soil cleanup goals presented in the ROD are final remediation goals (FRGs). The soil cleanup goals calculated in the Group C CMS are corrective action objectives (CAOs). The Depot worker FRG for lead at SWMUs 6 and 8 is 1,800 micrograms per gram (μg/g). The residential CAO for lead at SWMU 57 is 400 μg/g. These concentrations were used to outline the specific areas of each SWMU that require treatment to protect human health and the environment.

Sections 1.3.1, 1.3.2, and 1.3.3 briefly describe each SWMU, its history, and the extent of soil contamination.

1.3.1 SWMU 6

The Old Burn Area is located in the south-central portion of TEAD. It is a gently sloping, grassy area; bermed revetments are located in the eastern portion of the SWMU. Four natural surface drainages run off the north side of SWMU 6, where they are intercepted by a constructed drainage ditch.

This SWMU was the site of munitions testing, and the burning of boxes and wooden crates on the ground surface and in shallow trenches. These activities were discontinued in the 1970s. The disturbed area and former trenches have been filled, graded, and revegetated. The trenches still contain metal debris, spent or destroyed munitions, and potential unexploded ordnance (UXO).

The contaminants of concern (COCs) for the Old Burn Area are lead and 2,4-dinitrotoluene (2,4-DNT) in surface soil. Lead is the only COC in subsurface soil (Dames & Moore, 2000). The maximum concentrations of lead and 2,4-DNT detected in surface soil prior to the treatability study were 12,000 μg/g and 34 μg/g, respectively (Rust E&I, 1997a). The maximum concentration of lead detected in subsurface soil was 17,000 μg/g. The future land use for SWMU 6 is continued military use. Because the reasonably anticipated future land use is military, Depot worker FRGs are used for surface soil. Construction worker FRGs are used for subsurface soil. The FRG for lead for both receptors is 1,800 μg/g. Figure 1-4 shows the approximate area of contamination. Based on the additional treatability study data (i.e., field measurements) and using the surveyed SWMU boundary coordinates provided by the USACE, the TEAD base map has been refined since the ROD was published. The estimated area of potential lead soil contamination is approximately 5,516 square feet (ft^2). The depth of contamination varies from 0 to 7.5-feet bgs. The estimated total volume of lead-contaminated soil initially requiring treatment is approximately 300 cubic yards (yd^3).

The 2,4-DNT-contaminated soil is located in a drainage ditch in the northern part of SWMU 6, in a separate location from the lead contaminated soil. The estimated area of potential 2,4-DNT soil contamination is 3,000 ft^2 at a depth of 1 foot – for an estimated total volume of 120 yd^3 of soil. The FRG for 2,4-DNT is 4.7 μg/g. The S/S alternative does not include the treatment of 2,4-DNT contamination. As stated in the ROD (Dames & Moore, 2000), this material will be disposed of separately off-post.

1.3.2 SWMU 8

The Small Arms Firing Range is located near the western boundary of TEAD. It was used until 1994 by the National Guard, Army Reserve, Navy, and TEAD military

LEGEND:

TEAD-N BOUNDARY

AREA OUTLINES

SWMUs (SOLID WASTE MANAGEMENT UNITS)

6 OLD BURN AREA, OPERABLE UNIT 8

8 SMALL ARMS FIRING RANGE, OPERABLE UNIT 8

57 SKEET RANGE, GROUP C

FIGURE 1-2
LOCATION OF SWMUs 6, 8, AND 57
TOOELE ARMY DEPOT

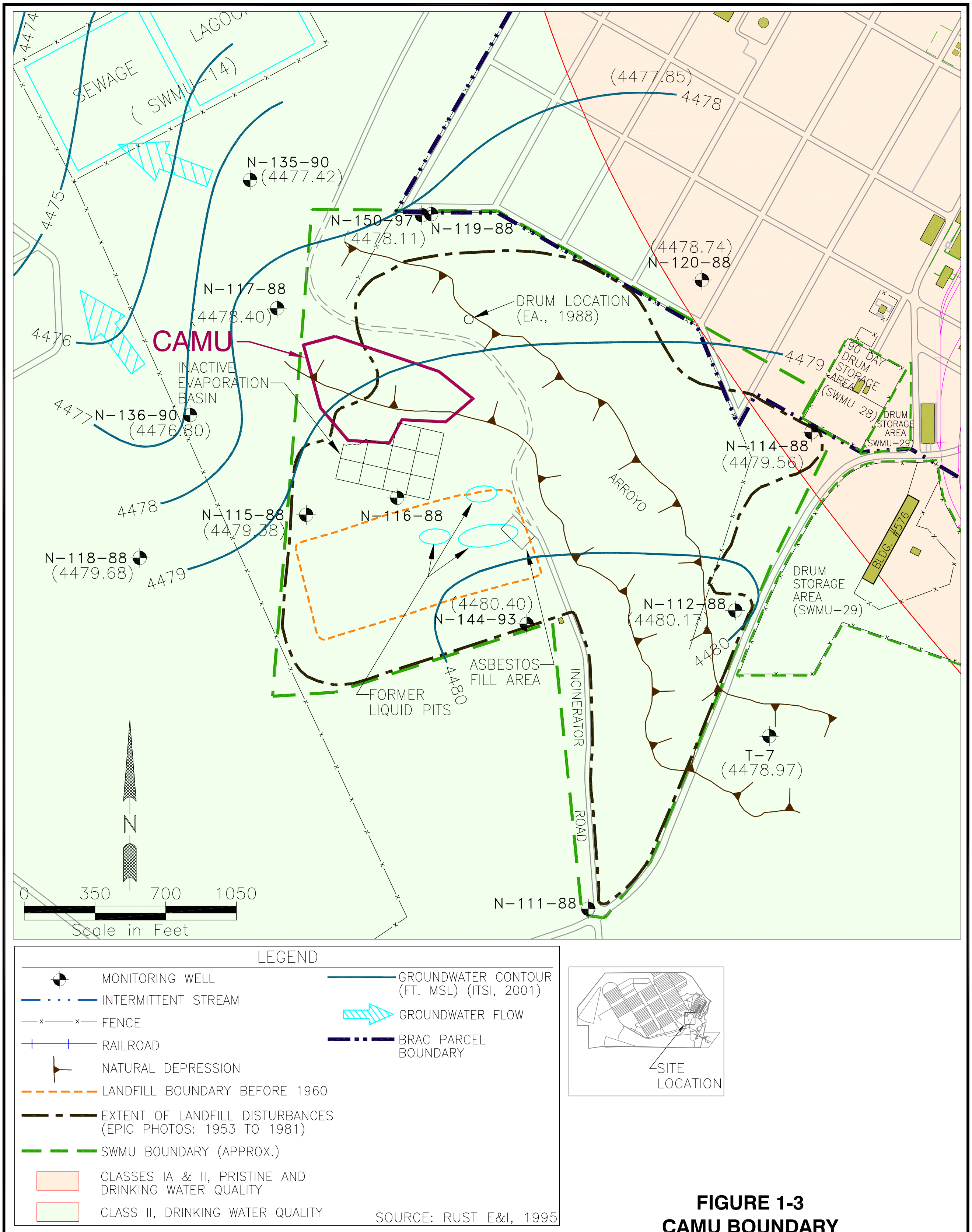
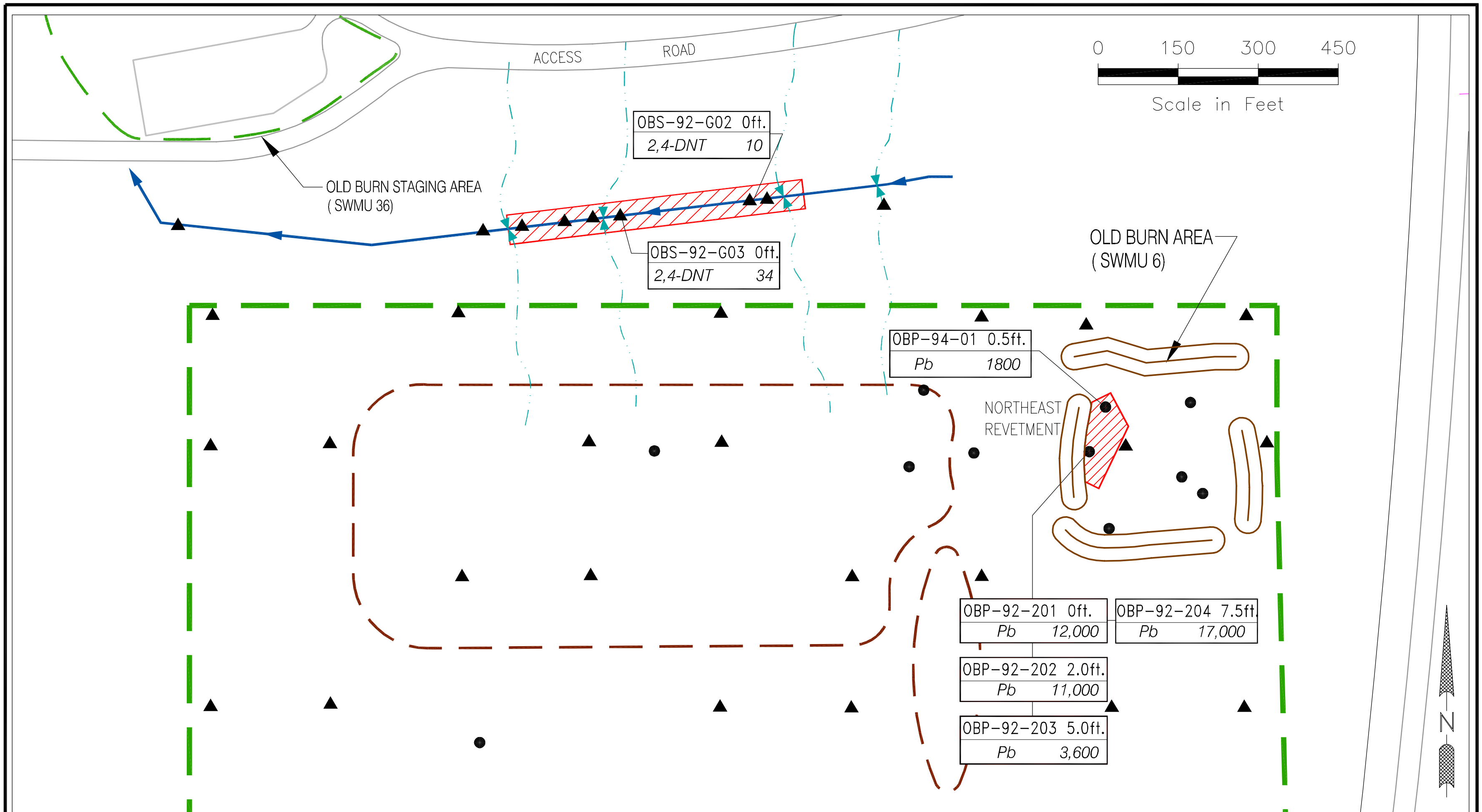


FIGURE 1-3
CAMU BOUNDARY
SANITARY LANDFILL AND PESTICIDE DISPOSAL AREA (SWMU 12/15)
TOOELE ARMY DEPOT

Dames & Moore



LEGEND

REVETMENTS

AREAS OF DISTURBANCE (EPIC PHOTO, 1963)

SHALLOW GULLEY (FLOW DIRECTION)

DRAINAGE DITCH

SWMU BOUNDARY (APPROX.)

TEST PIT SAMPLE

SURFACE SOIL SAMPLE

APPROXIMATE AREA OF LEAD OR 2,4-DNT CONTAMINATION

NOTE: CONCENTRATIONS ARE IN ug/g

SOURCE: RUST E&I, 1995

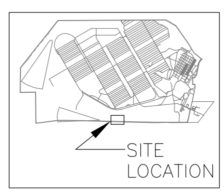


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FIGURE 1-4
LOCATION OF SURFACE AND SUBSURFACE SOIL COCs, AND APPROXIMATE AREA OF CONTAMINATION
THE OLD BURN AREA (SWMU 6)
TOOELE ARMY DEPOT

personnel for training in the use of small firearms. The range contains 20 firing stations, with targets located at 25, 50, 100, and 200 meters. Bermed areas behind the targets were used to stop rounds (Rust E&I, 1997a). Forty millimeter (40-mm) projectiles have been seen at SWMU 8 by Corps and Depot personnel during several site visits. The projectiles have been seen both intact and fragmented, and are considered dangerous in all cases because the fuzing cannot be seen (Personal communication from Bryton Johnson, USACE). The reasonably anticipated future land use for SWMU 8 is continued military use; thus, the Depot work FRG is used for surface soil.

Lead is the only COC at the Small Arms Firing Range. In investigations prior to the treatability study, elevated concentrations of lead were detected in numerous surface and shallow subsurface samples from the bullet stop areas, with a maximum of 12,000 μg/g at the surface and 33,000 μg/g at a depth of 0.5 foot below ground surface (bgs). The maximum concentration at 3 feet bgs was 1,500 μg/g. Samples taken beyond the second bullet stop showed lead levels below the Depot worker FRG of 1,800 μg/g.

Figure 1-5 shows the approximate area of contamination. The area of contamination was estimated in the Final FS Report (Dames & Moore, 1999) and is based on sample data and visual observation. Based on the additional treatability study data (i.e., new field measurements) and using the surveyed SWMU boundary coordinates provided by the USACE, the TEAD base map has been refined since the ROD was published. The estimated area of potential lead soil contamination is approximately 38,500 ft^2 at varying depths due to the slopes of the berms. The front berm is estimated to be approximately 8 feet high, it is anticipated excavation will occur to 2 feet bgs. There is also a small area of contamination in front of this berm that is estimated to require excavation to a depth of 1 foot. At the back berm, where lead contamination levels are elevated, the area is to be excavated to a depth of 2 feet. The estimated total volume of lead-contaminated soil requiring treatment is approximately 2,800 yd^3.

1.3.3 SWMU 57

The Skeet Range is located in the northern portion of the Administration Area of TEAD. It is located within the BRAC parcel and is to be used for residential purposes. This area was used for skeet and trap shooting from 1978 until the late 1990s; however, at the time of the RFI, skeet shooting consisted of occasional competitions and infrequent target practice. TEAD records indicate that lead shot was prohibited; however, because there is no documentation to indicate that this regulation was enforced at the Skeet Range, it is assumed that lead shot may have been used. Lead contamination does exist in the impact area (SAIC, 1997). The range no longer operates.

Several COCs were detected in soil at the Skeet Range. Because the reasonably anticipated future land use at SWMU 57 is residential, residential CAOs are used for surface soil. Based on comparing the maximum concentration of each contaminant of potential concern identified at SWMU 57 in the RFI (SAIC, 1997) to the residential CAO, the metals antimony, arsenic, and lead; and the semivolatile organic compounds (SVOCs) benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)-anthracene, and indeno(1, 2, 3-cd)pyrene were identified as COCs in surface soil at the Skeet Range. The metals and organic contamination were detected in separate areas of the SWMU, allowing the two types of contaminants to be treated by separate technologies. The lead contamination is located in the north area of the Skeet Range.

The treatability study only tested the lead-contaminated soil. In samples collected prior to the treatability study the maximum detected lead concentration in surface soil at SWMU 57 was 250,000 μg/g. The residential CAO is 400 μg/g. The distribution of COCs at SWMU 57 is presented in Figure 1-6. The estimated area of metals-contaminated soil is 52,000 ft^2. Based on soil sampling data presented in detail in the RFI (SAIC, 1997), the metals-contaminated soil is assumed to extend to a depth of 1 foot bgs. The volume of metals-contaminated soil at SWMU 57 is estimated to be 1,930 yd^3.

1.4 TECHNOLOGY DESCRIPTION

As a treatment technology, S/S is applicable for a variety of contaminants, primarily metals. This process has been used in the United States to treat waste since the 1950s (Portland Cement Association (PCA), 1998). The U.S. Environmental Protection Agency (EPA) has identified S/S as the best demonstrated available technology (BDAT) for 57 listed hazardous wastes (USEPA, 1993). S/S can be used to eliminate the hazardous characteristic of the waste, which allows less expensive disposal of the treated waste. S/S is an established technology for treating lead-contaminated soil; it has been successfully demonstrated at several installations, including Umatilla Chemical Depot, Hermiston, Oregon. Therefore, this treatability study focuses on evaluating reagents and processing techniques for the site-specific soil and contaminant levels at each of the TEAD SWMUs.

Solidification refers to changes in the physical properties of a waste; it often entails binding the waste in a monolithic solid of high structural integrity. This process restricts contaminant migration by decreasing the surface area exposed to leaching, (i.e., decreasing permeability). Stabilization refers to changes in the chemical properties of the hazardous constituents in a waste. This process converts the contaminants into a less soluble, less mobile, or less toxic form. S/S includes mixing the waste with inorganic reagents, which reduces mobility by both physical and chemical reactions (USACE, 1995).

1.5 PERFORMANCE CRITERIA

The treated material developed by this study was evaluated against performance criteria. These requirements include federal standards and USACE-specific tests. These performance criteria are presented in the *Engineering and Design Treatability Studies for Solidification/Stabilization of Contaminated Material* (USACE, 1995). Performance criteria for this study are both chemical and physical. The chemical tests are required to assure that the material is not a threat to the environment, and the physical tests confirm the durability of the optimized mixture. The physical tests also assure that the exposure

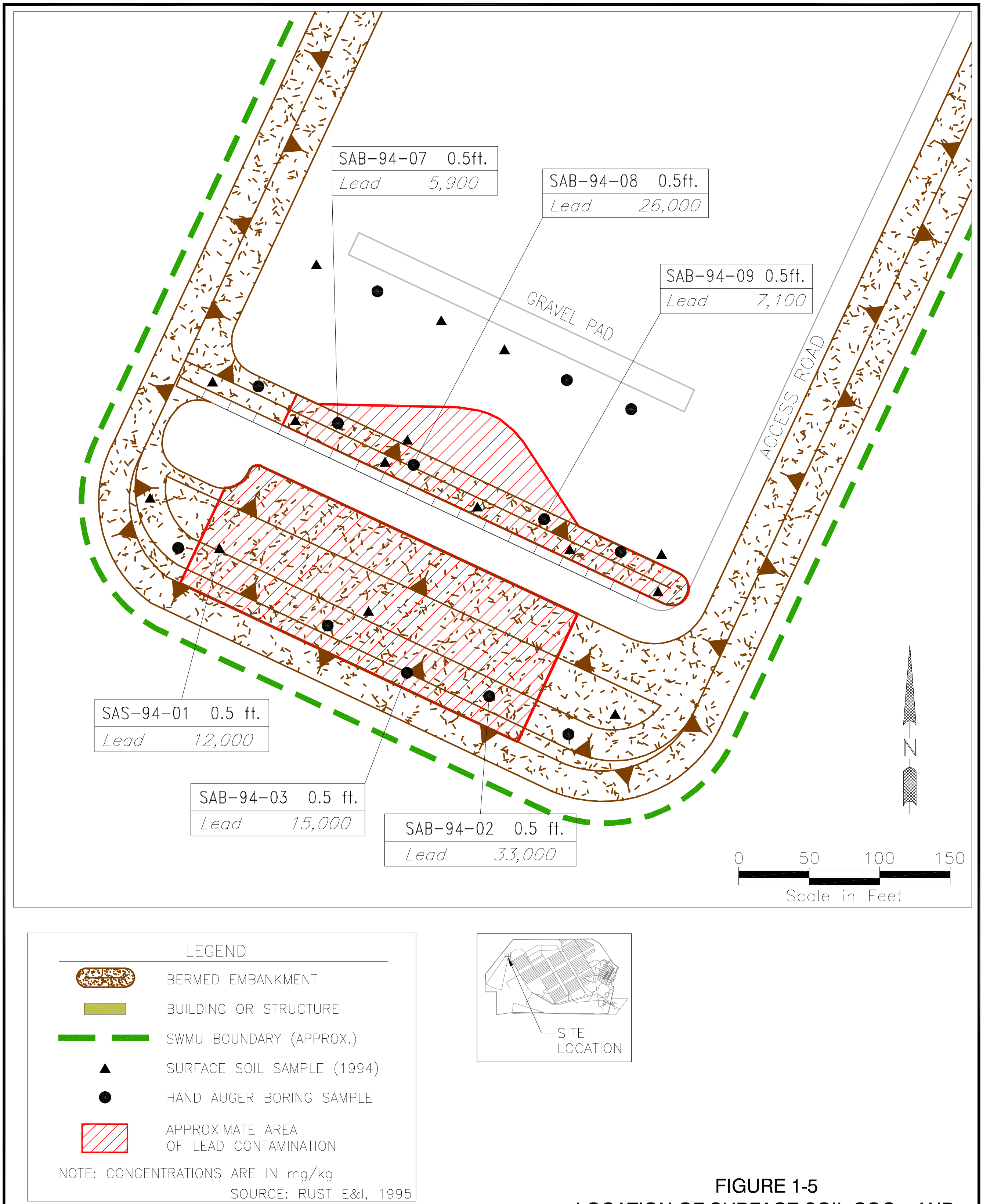

FIGURE 1-5
LOCATION OF SURFACE SOIL COCs, AND
APPROXIMATE AREA OF CONTAMINATION
SMALL ARMS FIRING RANGE (SWMU 8)
TOOELE ARMY DEPOT

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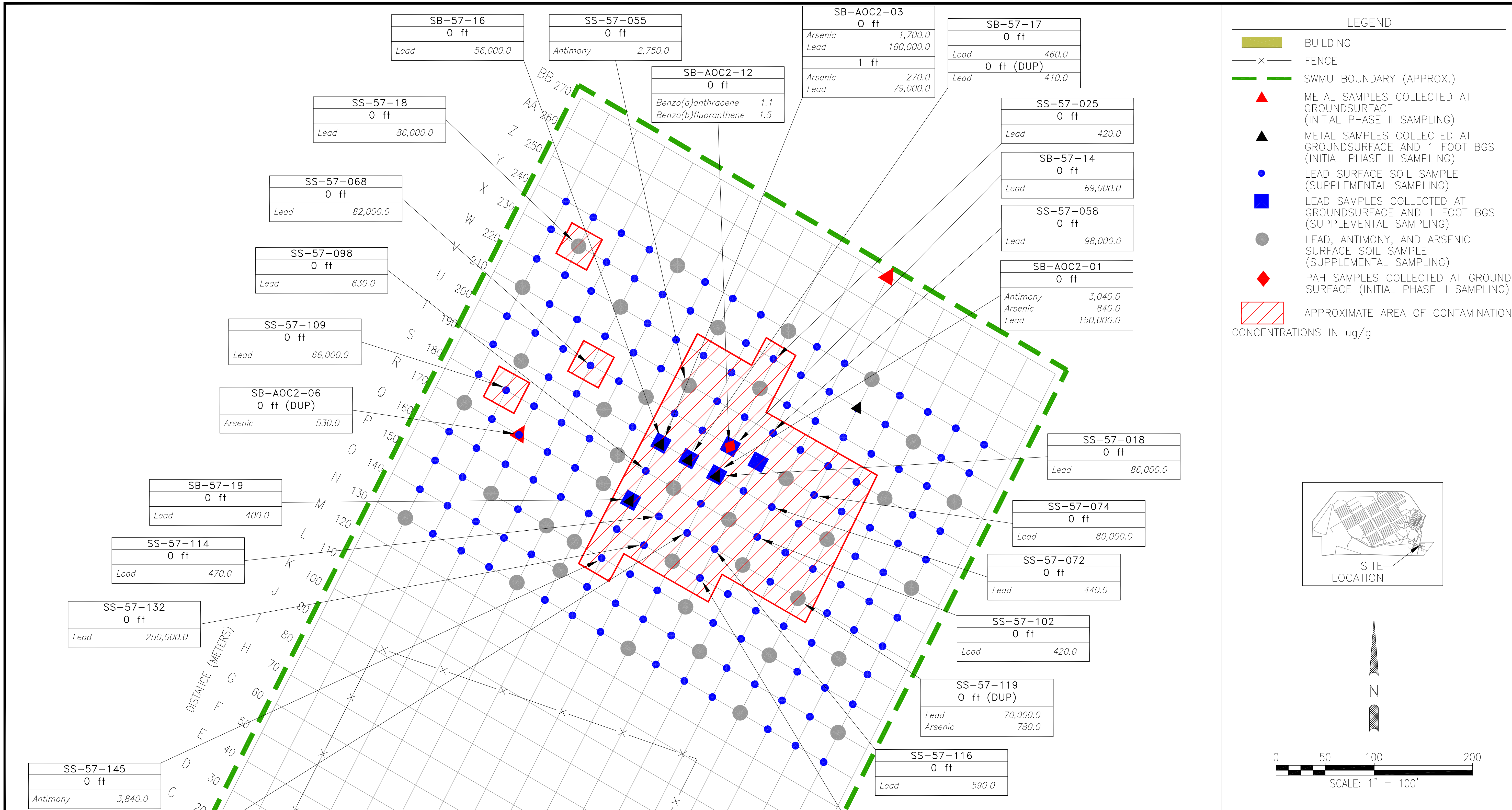

FIGURE 1-6
LOCATION OF SURFACE SOIL COCs
AND APPROXIMATE AREA OF
CONTAMINATION
AT THE SKEET RANGE (SWMU 57)
NORTH AREA
TOOELE ARMY DEPOT

URS Dames & Moore

pathway of lead-contaminated soil to human and ecological receptors is eliminated. Because the disposal area for SWMUs 6 and 8 is a CAMU, the LDRs do not apply (Disposal criteria for treated soil at SWMU 57 are addressed in the Group C CMS Report.). Instead, the chemical criteria are established on the basis of the protection of groundwater at the disposal area. In this case, a Synthetic Precipitation Leaching Procedure (SPLP) performance criterion is established based on a vadose zone transport model presented in Appendix A of the TSWP. The physical criteria are based on USACE guidance for treatability studies. Because the treated soil is to be placed in a CAMU, there is no absolute requirement for strength. The treated material will not be used as a foundation for a building or any other structure which requires high strength values. The criteria are based on best-engineering practices from other S/S studies.

Performance criteria used in this study are discussed in detail in the TSWP. Table 1-1 provides a summary of these criteria.

TABLE 1-1

Performance Criteria Used for the Solidification Treatability Study

Performance Criteria	
Chemical [(a)]	
SPLP lead	# 75 mg/L [(b)]
pH	∃ 8
Physical [(c)]	
Paint Filter Test	No free liquid
Unconfined Compressive Strength (UCS)	∃ 16 psi [(d)]
Bulk Density	# 25% increase in volume
Hydraulic Conductivity [(e)]	# 10^{-4} to 10^{-6} cm/s

(a) Chemical analytical samples were sent to Severn Trent Laboratory.
(b) SPLP value is based on SESOIL modeling: See Appendix A of the TSWP.
(c) Physical testing was performed at the URS-Radian soils laboratory in Austin, Texas.
(d) USC of greater than 50 pound per square inch (psi) is recommended by USACE, but is not required here because material reuse is not planned.
(e) Hydraulic conductivity testing occurs in Phase II.

1.6 REPORT ORGANIZATION

The remainder of the Report is organized as follows:

- Treatability study results (Section 2.0).
- References (Section 3.0).

- Field notes (Appendix A).
- Photographic Log (Appendix B).
- Hazardous Waste Manifest (Appendix C).
- Phase I and II Laboratory Results (Appendix D).
- Reagent Information (Appendix E).
- Data Quality Report (Appendix F).

2.0 TREATABILITY STUDY RESULTS

Treatability study samples were collected in the field June 18 through June 25, 2001. Sample collection and treatability study analyses were conducted according to the TSWP. The treatability study was designed in order to determine the optimal mixture of additives to achieve treatment objectives for lead, and to determine if S/S is capable of eliminating the hazardous condition of lead in soil and achieving a stable end product.

In order to meet these objectives, the study required several steps:

1) Collecting screening samples to guide the selection of bulk samples for treatability testing,

2) Collecting bulk samples,

3) Phase I testing – creating mixtures of bulk samples and four stabilizing reagents (at 10 percent by weight) and conducting physical and chemical testing of these mixtures,

4) Evaluating Phase I testing against performance criteria to guide Phase II testing

5) Phase II testing – creating mixtures of bulk samples and four stabilizing reagents (at percentages based on Phase I results) and conducting physical and chemical testing of these mixtures,

6) Evaluating Phase II results against performance criteria to guide optimization testing, and

7) Optimization testing – determining the hydraulic conductivity of the optimal reagent mixture for each SWMU soil.

The following sections provide a description of each of these steps and summarize the results from each. A detailed description of the treatability study design is provided in the TSWP.

2.1 <u>SCREENING SAMPLING AND RESULTS</u>

Five preliminary soil samples were collected from each of the three SWMUs in areas known to contain high levels of lead contamination. Sample locations for each SWMU are shown in Figures 2-1, 2-2, and 2-3. These preliminary samples were submitted to the laboratory for 24-hour turnaround analysis of total lead. The analyses performed for all phases of the study are summarized in Table 2-1.

TABLE 2-1

Summary of Chemical Analysis for Treatability Study
SWMUs 6, 8, and 57

Area	Task	Description	Soil		Water	
			Lead (SW6010b)	**SPLP Metals (SW1312)**	**Lead (SW6010b)**	**SPLP Metals (SW1312)**
The Old Burn Area (SWMU 6)	Preliminary soil samples	Composite samples [(a)]	5	0	1	
	Bulk soil sample	Pretreatment sample [(b)]	1	1		
		Post treatment samples [(c)]		12		2
The Small Arms Firing Range (SWMU 8)	Preliminary soil samples	Composite samples [(a)]	5	0	1	
	Bulk soil sample	Pretreatment sample [(b)]	1	1		
		Post treatment samples [(c)]		12		2
Skeet Range (SWMU 57)	Preliminary soil samples	Composite samples [(a)]	5	0	1	
	Bulk soil sample	Pretreatment sample [(b)]	1	1		
		Post treatment samples [(c)]		12		2
Waste Disposal	Decontamination of sampling equipment	DI water (lead only), decontamination fluids and solids for SPLP Metals [(d)]		1	1	1
		Total Site Samples	18	40	4	7
		Quality Control Samples (Duplicate/MS + MSD)	2/1	2/(e)	0/0	6/(e)

(a) Each composite sample was composed of a mixture of five subsamples. The preliminary samples required a 24-hour turnaround time. One rinsate sample was collected at each SWMU. A duplicate sample was collected at composite sample SS080105R.

(b) These samples required a 14-day turnaround time. Each sample was analyzed for pH.

(c) Soil samples were obtained by crushing treated soils of each mixture. The crushed sample was run through a $^3/_8$-inch sieve. A SPLP extraction was performed on the sieved sample. Other water SPLP samples were effluent from hydraulic conductivity tests on 6 percent fly ash and Portland cement mixtures.

(d) This included one sample of distilled water and one sample each from the decontamination liquids and solids.

(e) The laboratory used liquid generated in leaching procedure for MS/MSD.

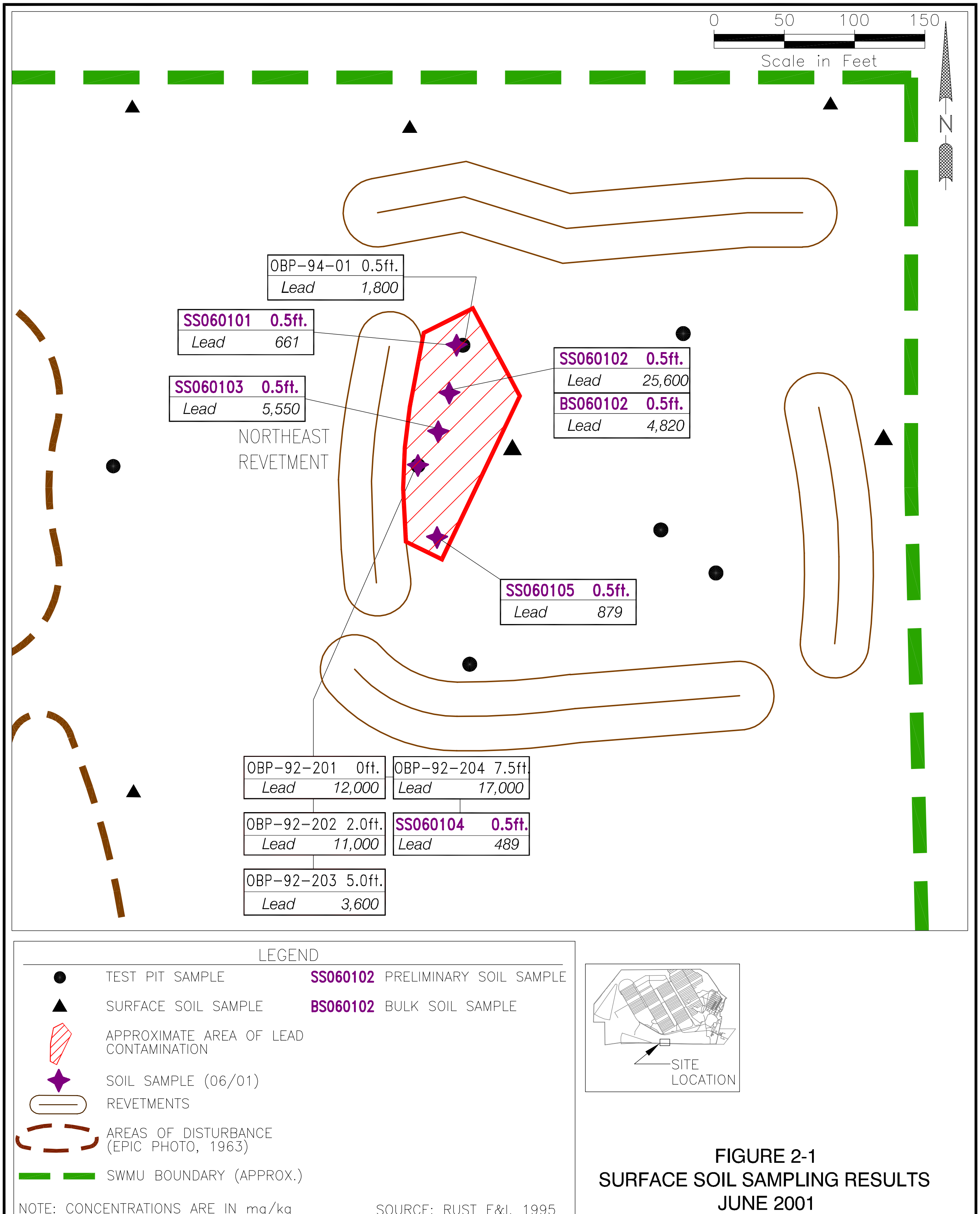

FIGURE 2-1
SURFACE SOIL SAMPLING RESULTS
JUNE 2001
THE OLD BURN AREA (SWMU 6)
TOOELE ARMY DEPOT

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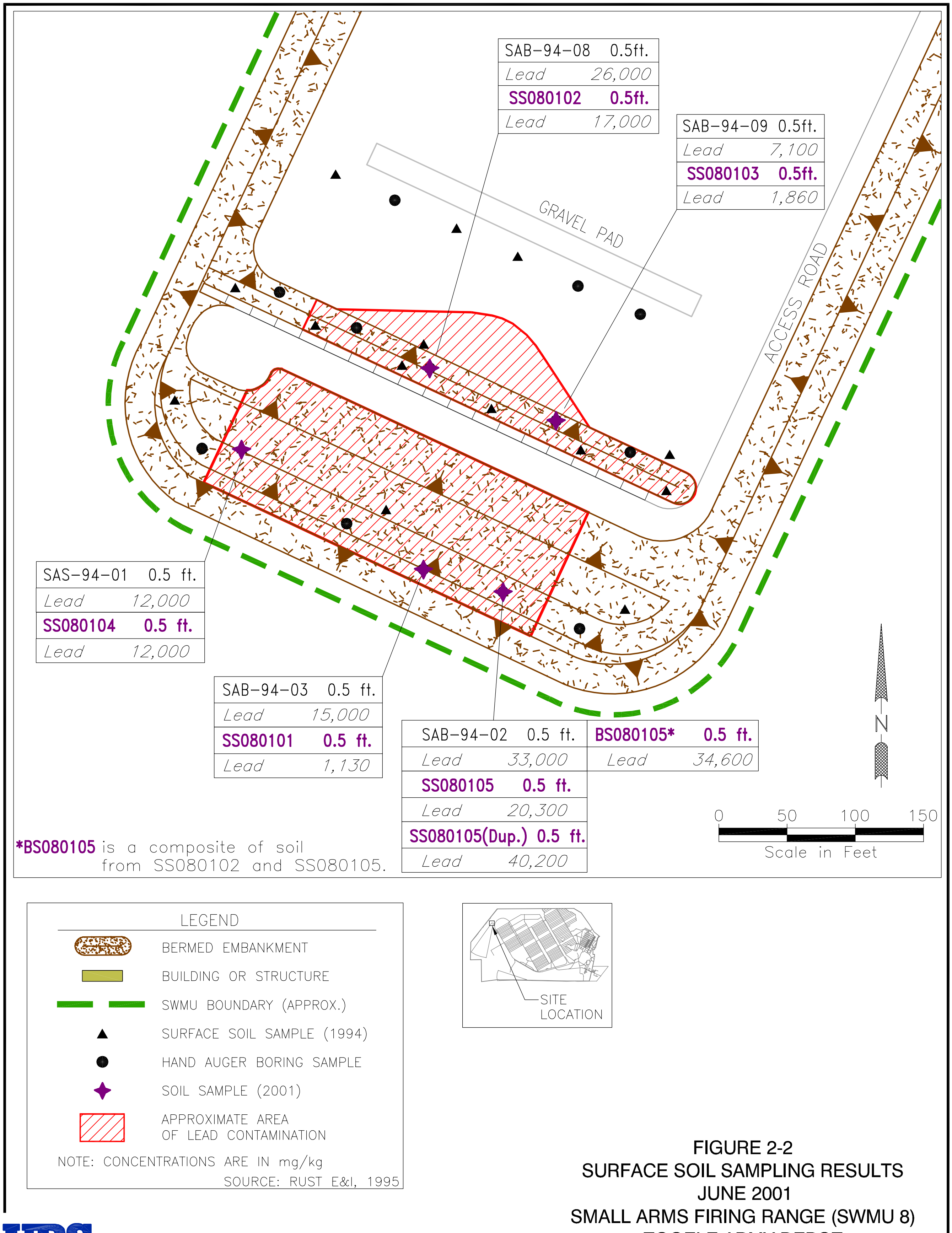

FIGURE 2-2
SURFACE SOIL SAMPLING RESULTS
JUNE 2001
SMALL ARMS FIRING RANGE (SWMU 8)
TOOELE ARMY DEPOT

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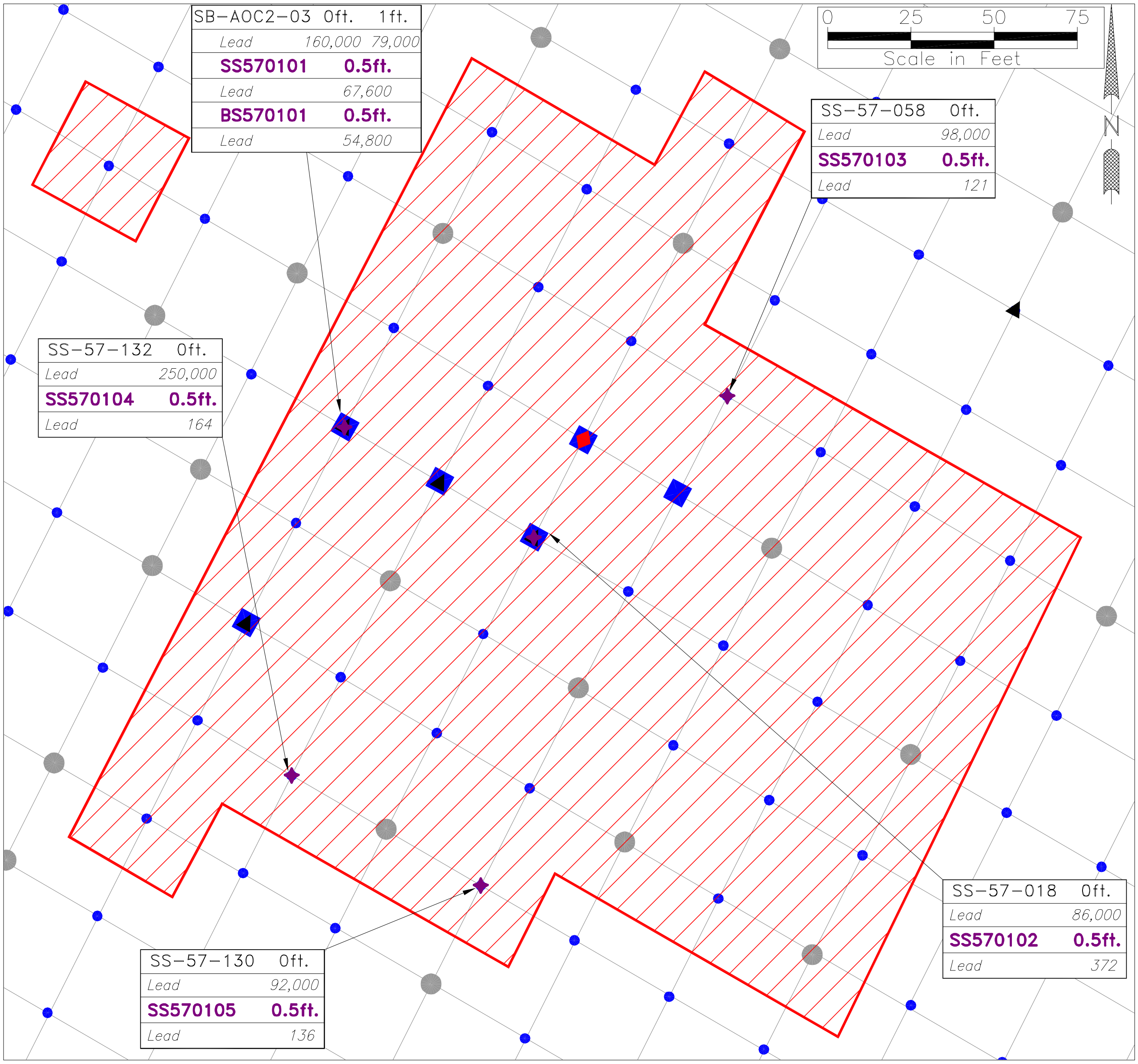

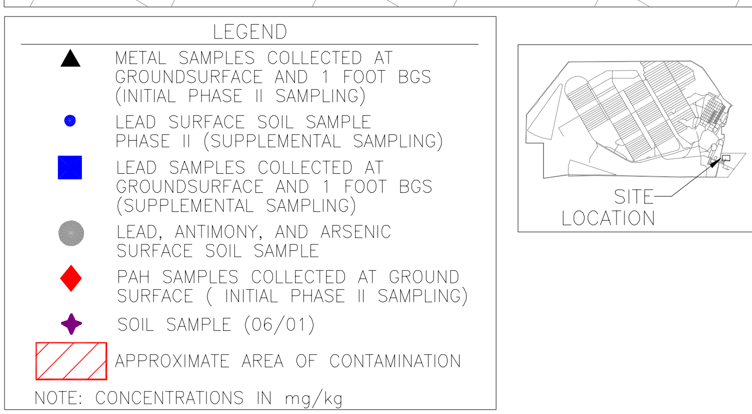

FIGURE 2-3
SURFACE SOIL SAMPLING RESULTS
JUNE 2001
AT THE SKEET RANGE (SWMU 57)
NORTH AREA
TOOELE ARMY DEPOT

URS Dames & Moore

Results of the screening sample analysis indicated the following locations had the highest lead concentration:

SWMU	Sample	Lead (μg/g)
6	SS060102	25,600
8	SS080105R*	40,200
57	SS570101	67,600

* Duplicate of SS080105.

Detailed results for all samples are presented on Figures 2-1, 2-2, and 2-3, and in Table 2-2.

According to the TSWP, the sample location with the highest concentration of lead greater than 1,800 μg/g at each SWMU was to be selected for treatability study testing. However, during screening sampling at SWMU 8 bullet casings were observed at SS080102. Therefore, it was decided that the bulk sample for treatability testing at SWMU 8 would be a composite from location SS080102 and SS080105 to include casings in the laboratory testing. Bulk sample locations at SWMU 6 and 57 were selected based on the highest lead concentration.

2.2 BULK SAMPLING FOR TREATABILITY STUDY TESTING

Two 5-gallon buckets of soil from the selected location were collected from each SWMU. Field observations during screening sampling and results from the RI led to a minor modification of sample collection procedures for bulk sampling. At SWMUs 6 and 8, narrower and deeper (approximately 2 ft bgs) samples were collected, based on the results of the RI, where lead concentrations occurred at 6 inches bgs or greater. At SWMU 57, a broader and shallower sample was collected due to the presence of lead shot observed on the surface during screening sampling. In each case, the intent was to "spike" the sample with high lead levels for laboratory testing, establishing a "worst case" for treatment.

2.3 DATA QUALITY AND USABILITY ASSESSMENT

In addition to the laboratory Level 1 and 2 data reviews, 100 percent of the analytical data was reviewed by the USACE project chemist in order to assess data quality and usability. For each analytical method, the following parameters were evaluated:

- Sample Preservation
- Holding Times
- Instrument Calibration (as presented in the laboratory narrative)
- Interference Check Samples (as applicable)

TABLE 2-2

Screening Samples Total Lead Results

Site:	**SWMU 6**
Date:	**6/19/01**
Sample ID	**Lead (µg/g)**
SS060101	661
SS060102	$\boxed{25600}$
SS060103	$\boxed{5550}$
SS060104	489
SS060105	879

Site:	**SWMU 8**
Date:	**6/19/01**
Sample ID	**Lead (µg/g)**
SS080101	1,130
SS080102	$\boxed{17{,}000}$
SS080103	$\boxed{4{,}530}$
SS080104	$\boxed{1{,}860}$
SS080105	$\boxed{20{,}300}$
SS080105R*	$\boxed{40{,}200}$

Site:	**SWMU 57**
Date:	**6/19/01**
Sample ID	**Lead (µg/g)**
SS070101	$\boxed{67{,}600}$
SS070102	372
SS070103	121
SS070104	164
SS070105	136

Notes:
*Duplicate of SS080105
$\boxed{}$ Indicates lead >1,800 µg/g (and suitable as bulk location).

- Serial Dilutions (as applicable)
- Post Spikes (as applicable)
- Method Blanks
- Laboratory Control Spikes
- Matrix Spikes
- Matrix Duplicates

For metals analysis by Method 6010B, several sample results were estimated due to the following minor quality control (QC) deficiencies: improper sample preservation, matrix spike imprecision, low matrix spike recoveries, matrix duplicate imprecision, and positive detects in the continuing calibration blanks.

For mercury analysis by Method SW7470B and pH analysis by Method SW9045C, a few sample results were estimated due to the following minor QC deficiencies: improper temperature preservation and holding time expiration.

The QC deficiencies are considered minor and do not impact data usability. The data are considered usable for the intended purpose of evaluating the stabilization of lead during and after treatment. The data quality report is presented in Appendix F.

2.4 PHASE I TESTING AND RESULTS

Upon receipt at the soils laboratory, each of the three bulk samples was analyzed for bulk density, moisture content, and percent gravel (results are presented on Table 2-3, and in Appendix D). The soil was then passed through a 1-inch sieve, and mechanically mixed to ensure homogenization. No attempt was made to remove lead shot. Subsamples of the untreated soil were analyzed for pH, total lead, and SPLP metals to provide a baseline for post-treatment comparison. Total lead results from the bulk samples are presented on Table 2-3 indicating all samples had lead concentrations greater than 1,800 μg/g. SPLP metals and pH results are presented in Table 2-4. The SPLP results indicate that prior to mixing soil with reagents, lead was not detected above the 75 miligram per liter (mg/L) criterion for any SWMU.

For Phase I, subsamples of the homogenized soils from each SWMU were mixed with 10 percent by weight of each reagent plus water for each of four reagents: Portland cement, lime kiln dust, cement kiln dust, and fly ash. The paint filter test was run on an aliquot of each mixture immediately after preparation to check for free liquids; none were present.

TABLE 2-3

Bulk Sample Pretreatment Results

Site:	SWMU 6	SWMU 8	SWMU 57
Date:	6/21/01	6/21/01	6/21/01
Sample ID	BS060102	BS080105*	BS570101
Lead (µg/g)	4,820	34,600	54,800
% gravel	19	4	3
% moisture	1.1	0.10	0.90

* Composite sample from location SS080102 and SS080105.

TABLE 2-4

Bulk Sample SPLP and pH Results (metals concentrations in mg/L)

Site:	**SWMU 6**	**SWMU 8**	**SWMU 57**
Sample ID:	**BS060102**	**BS080105***	**BS570101**
Arsenic	□ 0.100	□ 0.100	0.305
Barium	□ 1.00	□ 1.00	□ 1.00
Cadmium	□ 0.0500	□ 0.0500	□ 0.0500
Chromium	□ 0.0500	□ 0.0500	□ 0.0500
Lead	0.279	2.81	3.27
Mercury	□ 0.0020	□ 0.0020	□ 0.0020
Selenium	□ 0.100	□ 0.100	□ 0.100
Silver	□ 0.0500	□ 0.0500	□ 0.0500
pH	8.30	8.43	7.10

* Composite sample from location SS080102 and SS080105.

For each of the four mixtures two 3-inch by 6-inch cylinders and one 9-inch by 9-inch pan, were prepared and allowed to cure. After 7 days, the cylindrical specimens were tested for Unconfined Compressive Strength (UCS), SPLP metals, pH, bulk density and volume change. The pan specimens were tested after 2, 4, 7, 10 and 14 days with a bench penetrometer to determine the curing rates for each mixture. After 4 days all of the mixtures have cured above 1,400 psi. It appears that Portland cement mixtures have the highest curing rate and at each of the three SWMUs, and the SWMU 6 mixtures cure faster than SWMU 8 and 57 mixtures. Penetrometer results are presented in Appendix D.

Results of the Phase I SPLP testing were evaluated against the performance criteria in Table 1-1. Fly ash, CKD and LKD mixtures have lower USC results than Portland cement (as expected) and all are above the 16 psi criteria. The pH criteria of greater than or equal to 8 was accomplished by all mixtures. The bulk density values are all well below the performance criteria of less than a 25 percent increase because the mixtures shrink after curing. SPLP analysis indicated that lead was detected above the 75 mg/L criterion only in lime kiln dust mixtures at SWMU 8 and 57. Other metals were detected at very low levels (or not at all) in the SPLP leachate. UCS and other physical tests indicated that all reagents were suitable for Phase II testing. Complete SPLP metals results are presented in Table 2-5. Physical and chemical test results from the Phase I testing are summarized in Table 2-6.

2.5 PHASE II TESTING AND RESULTS

Based on the results of the bulk sample and Phase I testing, mixtures of the samples and reagents were prepared with reagent dosages lowered by 2 and 4 percent (i.e., 8 and 6 percent by weight). The Phase II subsamples were prepared for each of the four reagents. The paint filter test was run on an aliquot of each mixture immediately after preparation to check for free liquids; none were present. Subsamples were prepared in cylinders and pans as in Phase I. After 7 days, the cylindrical specimens were tested for SPLP metals, pH, UCS, bulk density, and volume change. The pan specimens were tested after 2, 4, 7, 10 and 14 days with a bench penetrometer to determine the curing rates for each mixture. After 4 days, all of the 6 percent mixtures cured above 2,400 psi and all of the 8 percent mixtures cured above 3,500 psi. It appears that the 6 percent mixtures at SWMU 8 have the lowest curing rates of all the mixes run in Phase II. Penetrometer results are presented in Appendix D.

SPLP lead was detected above the 75 mg/L criterion in the mixture of 8 percent lime kiln dust with soil from SWMU 8. Lead was detected in other mixtures below the 75 mg/L criterion. Arsenic was also detected in the SPLP results in four mixtures: 6 and 8 percent cement kiln dust and fly ash with soil from SWMU 57. SPLP results are presented in Table 2-7. A summary of physical and chemical tests is presented in Table 2-8. Fly ash, CKD and LKD mixtures have lower USC results than Portland cement (as expected) and all are above the 16 psi criteria. The pH criterion of greater than or equal to 8 was accomplished by all mixtures. The bulk density values are all well below the performance criteria of less than a 25 percent increase because the mixtures shrink after curing.

Table 2-9 presents the hydraulic conductivity results which were performed on 6 percent Portland cement mixtures and the 6 percent fly ash mixtures for each SWMU. The hydraulic conductivity range of 10^{-4} to 10^{-6} centimeter per second (cm/s) is believed adequate to retard infiltration through the treated material. The hydraulic conductivity results are within the performance criteria range except for in the mixture of 6 percent fly ash at SWMU 6. This result is just below the range and will likely be acceptable (i.e., slightly increase) if the gravel from the site is included in the mixture during full-scale treatment.

Leachate samples from the hydraulic conductivity test were collected for metals analysis. The hydraulic conductivity controls infiltration of rainwater through the treated material. Testing for metals on the leachate from the hydraulic conductivity test is

TABLE 2-5

Phase I SPLP and pH Results
(metals concentrations in mg/L)

Additive	SWMU 6 - 10% PC	SWMU 6 - 10% FA	SWMU 6 - 10% CKD	SWMU 6 - 10% LKD
Arsenic	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Barium	□ 1.00	0.465	0.640	1.07
Cadmium	□ 0.0500	□ 0.0020	□ 0.0020	□ 0.0020
Chromium	□ 0.0500	0.0265	0.0128	□ 0.0500
Lead	0.0678	0.0208	□ 0.0500	0.680
Mercury	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020
Selenium	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Silver	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
pH	12.40	11.45	12.29	12.54

Additive	SWMU 8 - 10% PC	SWMU 8 - 10% FA	SWMU 8 - 10% CKD	SWMU 8 - 10% LKD
Arsenic	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Barium	0.488	0.566	□ 1.00	1.13
Cadmium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Chromium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Lead	20.0	0.0396	6.45	112
Mercury	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020
Selenium	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Silver	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
pH	12.39	11.51	12.48	12.56

Additive	SWMU 57 - 10% PC	SWMU 57 - 10% FA	SWMU 57 - 10% CKD	SWMU 57 - 10% LKD
Arsenic	0.0401	□ 0.100	0.0544	□ 0.100
Barium	0.395	□ 1.00	0.557	0.622
Cadmium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Chromium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Lead	5.59	0.0637	3.10	107
Mercury	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020
Selenium	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Silver	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
pH	12.46	11.28	12.36	12.58

Additive Codes:

PC Portland Cement
FA Fly Ash
CKD Cement Kiln Dust
LKD Lime Kiln Dust

TABLE 2-6

Phase I Physical and Chemical Test Results

10% Additive - SWMU 6

Additive	%H_2O	Lead <75 mg/L (Pass/Fail)	pH	Paint Filter Test (Pass/Fail)	Average UCS (psi)	Bulk Density (% increase in volume)
Portland Cement	10	Pass	12.4	Pass	463	-0.05
Fly Ash	10	Pass	11.45	Pass	61	-0.08
Cement Kiln Dust	10	Pass	12.29	Pass	127	-0.09
Lime Kiln Dust	10	Pass	12.54	Pass	200	-0.07

10% Additive - SWMU 8

Additive	%H_2O	Lead <75 mg/L (Pass/Fail)	pH	Paint Filter Test (Pass/Fail)	Average UCS (psi)	Bulk Density (% increase in volume)
Portland Cement	10	Pass	12.39	Pass	397	-0.18
Fly Ash	10	Pass	11.51	Pass	164	-0.15
Cement Kiln Dust	10	Pass	12.48	Pass	183	-0.14
Lime Kiln Dust	10	Fail	12.56	Pass	158	-0.11

10% Additive - SWMU 57

Additive	%H_2O	Lead <75 mg/L (Pass/Fail)	pH	Paint Filter Test (Pass/Fail)	Average UCS (psi)	Bulk Density (% increase in volume)
Portland Cement	10	Pass	12.46	Pass	135	-0.27
Fly Ash	10	Pass	11.28	Pass	145	-0.33
Cement Kiln Dust	10	Pass	12.36	Pass	87	-0.33
Lime Kiln Dust	10	Fail	12.58	Pass	451	-0.30

TABLE 2-7

Phase II SPLP and pH Results (metals concentrations in mg/L)

SWMU 6

	6% PC	6% FA	6% CKD	6% LKD	8% PC	8% FA	8% CKD	8% LKD
Arsenic	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Barium	□ 1.00	□ 1.00	□ 1.00	□ 1.00	□ 1.00	□ 1.00	□ 1.00	□ 1.00
Cadmium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Chromium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Lead	□ 0.0500	□ 0.0500	□ 0.0500	2.32	0.0541	□ 0.0500	□ 0.0500	0.755
Mercury	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020
Selenium	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Silver	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
pH	12.07	10.94	11.33	11.94	11.93	11.2	11.72	11.90

SWMU 8

	6% PC	6% FA	6% CKD	6% LKD	8% PC	8% FA	8% CKD	8% LKD
Arsenic	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Barium	□ 1.00	□ 1.00	□ 1.00	□ 1.00	□ 1.00	□ 1.00	□ 1.00	□ 1.00
Cadmium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Chromium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Lead	6.17	□ 0.0500	0.25	41.5	17.9	□ 0.0500	1.86	84.2
Mercury	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020
Selenium	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Silver	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
pH	12.07	10.83	11.56	12.15	11.99	11.16	12.09	12.30

TABLE 2-7 (cont'd)

SWMU 57

	6% PC	6% FA	6% CKD	6% LKD	8% PC	8% FA	8% CKD	8% LKD
Arsenic	□ 0.100	0.173	0.139	□ 0.100	□ 0.100	0.153	0.105	□ 0.100
Barium	□ 1.00	□ 1.00	□ 1.00	□ 1.00	□ 1.00	□ 1.00	□ 1.00	□ 1.00
Cadmium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Chromium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Lead	5.99	□ 0.0500	□ 0.0500	27.3	9.93	□ 0.0500	1.24	45.8
Mercury	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020
Selenium	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Silver	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
pH	11.92	10.02	11.09	11.99	12.06	10.91	12.01	12.47

<u>Additive Codes</u>:

PC Portland Cement
FA Fly ash
CKD Cement kiln dust
LKD Lime kiln dust

TABLE 2-8

Phase II Physical and Chemical Test Results

6% Additive - SWMU 6

Additive	% H_2O	Lead <75 mg/L (Pass/Fail)	pH	Paint Filter Test (Pass/Fail)	UCS (psi)	Hydraulic Conductivity cm/s	Bulk Density (% increase in volume)	Moisture/ Std. Proctor
Portland Cement	8	Pass	12.07	Pass	472	1.00E-05	-0.09	11
Fly Ash	8	Pass	10.94	Pass	70	7.39E-07	-0.13	NT
Cement Kiln Dust	8	Pass	11.33	Pass	178	NT	-0.13	NT
Lime Kiln Dust	8	Pass	11.94	Pass	168	NT	-0.09	NT

8% Additive - SWMU 6

Additive	% H_2O	Lead <75 mg/L (Pass/Fail)	pH	Paint Filter Test (Pass/Fail)	UCS (psi)	Hydraulic Conductivity cm/s	Bulk Density (% increase in volume)	Moisture/ Std. Proctor
Portland Cement	8	Pass	11.93	Pass	409	NT	-0.07	NT
Fly Ash	8	Pass	11.2	Pass	67	2.09E-08	-0.09	NT
Cement Kiln Dust	8	Pass	11.72	Pass	140	NT	-0.13	NT
Lime Kiln Dust	8	Pass	11.9	Pass	120	NT	-0.05	NT

6% Additive - SWMU 8

Additive	% H_2O	Lead <75 mg/L (Pass/Fail)	pH	Paint Filter Test (Pass/Fail)	UCS (psi)	Hydraulic Conductivity cm/s	Bulk Density (% increase in volume)	Moisture/ Std. Proctor
Portland Cement	8	Pass	12.07	Pass	552	2.20E-06	-0.14	11.5
Fly Ash	7	Pass	10.83	Pass	164	2.70E-06	-0.15	NT
Cement Kiln Dust	7	Pass	11.56	Pass	130	NT	-0.14	NT
Lime Kiln Dust	8	Pass	12.15	Pass	141	NT	-0.15	NT

TABLE 2-8 (cont'd)

8% Additive - SWMU 8

Additive	% H_2O	Lead <75 mg/L (Pass/Fail)	pH	Paint Filter Test (Pass/Fail)	UCS (psi)	Hydraulic Conductivity cm/s	Bulk Density (% increase in volume)	Moisture/ Std. Proctor
Portland Cement	8	Pass	11.99	Pass	533	NT	-0.12	NT
Fly Ash	8	Pass	11.16	Pass	199	4.28E-07	-0.16	NT
Cement Kiln Dust	8	Pass	12.09	Pass	150	NT	-0.12	NT
Lime Kiln Dust	8	Fail	12.3	Pass	109	NT	-0.12	NT

6% Additive - SWMU 57

Additive	% H_2O	Lead <75 mg/L (Pass/Fail)	pH	Paint Filter Test (Pass/Fail)	UCS (psi)	Hydraulic Conductivity cm/s	Bulk Density (% increase in volume)	Moisture/ Std. Proctor
Portland Cement	8	Pass	11.92	Pass	369	1.30E-06	-0.29	12.7
Fly Ash	7	Pass	10.02	Pass	113	2.69E-06	-0.30	NT
Cement Kiln Dust	7	Pass	11.09	Pass	134	NT	-0.28	NT
Lime Kiln Dust	7	Pass	11.99	Pass	58	NT	-0.29	NT

8% Additive - SWMU 57

Additive	% H_2O	Lead <75 mg/L (Pass/Fail)	pH	Paint Filter Test (Pass/Fail)	UCS (psi)	Hydraulic Conductivity cm/s	Bulk Density (% increase in volume)	Moisture/ Std. Proctor
Portland Cement	8	Pass	12.06	Pass	468	NT	-0.27	NT
Fly Ash	8	Pass	10.91	Pass	151	4.23E-07	-0.27	NT
Cement Kiln Dust	8	Pass	12.01	Pass	127	NT	-0.27	NT
Lime Kiln Dust	8	Pass	12.47	Pass	87	NT	-0.27	NT

NT = not tested.

assumed to be representative of conditions observed in the field after full-scale remediation. Table 2-9 presents the analytical lead results for the leachate. All lead concentrations are well below the 75 mg/L criterion.

TABLE 2-9

Hydraulic Conductivity Lead Leachate Results
(concentrations in mg/L)

Sample ID	6% Portland Cement	6% Fly Ash
SWMU 6	0.435	0.0056
SWMU 6 Dup	0.440	0.0047
SWMU 8	5.05	0.0886
SWMU 8 Dup	4.86	0.0897
SWMU 57	0.908	0.0072
SWMU 57 Dup	0.998	0.0064

SPLP and pH results (Pretreatment, Phase I and Phase II) are presented in Tables 2-10, 2-11, and 2-12, respectively. These tables summarize the data by SWMU and are used to evaluate the effectiveness of treatment.

2.6 OPTIMIZATION

Based on the Phase I and Phase II results, only lime kiln dust failed to meet the performance criteria. At all three dosage levels (10, 8 and 6 percent), the fly ash, cement kiln dust, and Portland cement mixtures provide a suitable solidification mixture for full scale remediation of the lead-contaminated soil at SWMUs 6 and 8. However, fly ash and cement kiln dust may not be suitable for solidification treatment at SWMU 57 due to SPLP arsenic values.

2.7 DECONTAMINATION AND WASTE HANDLING

2.7.1 Decontamination

All field sampling equipment was decontaminated prior to use and between each sample. Equipment was cleaned with distilled water and detergent, and rinsed with distilled water.

A field equipment rinsate blank was collected and analyzed for total lead. Lead was below the detection limit in this water sample (DW062501). Typically, the absence of the target analyte from rinsate indicates that decontamination procedures were adequate in preventing cross-contamination during sampling.

TABLE 2-10

SWMU 6 – Pretreatment, Phase I and Phase II, SPLP and pH Results (metals concentrations in mg/L)

	Pretreatment	**10% PC**	**8% PC**	**6% PC**	**10% FA**	**8% FA**	**6% FA**
Arsenic	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Barium	□ 1.00	□ 1.00	□ 1.00	□ 1.00	0.465	□ 1.00	□ 1.00
Cadmium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0020	□ 0.0500	□ 0.0500
Chromium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	0.0265	□ 0.0500	□ 0.0500
Lead	0.279	0.0678	0.0541	□ 0.0500	0.0208	□ 0.0500	□ 0.0500
Mercury	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020
Selenium	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Silver	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
pH	8.30	12.40	11.93	12.07	11.45	11.2	10.94

	Pretreatment	**10% CKD**	**8% CKD**	**6% CKD**	**10% LKD**	**8% LKD**	**6% LKD**
Arsenic	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Barium	□ 1.00	0.640	□ 1.00	□ 1.00	1.07	□ 1.00	□ 1.00
Cadmium	□ 0.0500	□ 0.0020	□ 0.0500	□ 0.0500	□ 0.0020	□ 0.0500	□ 0.0500
Chromium	□ 0.0500	0.0128	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Lead	0.279	□ 0.0500	□ 0.0500	□ 0.0500	0.680	0.755	2.32
Mercury	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020
Selenium	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Silver	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
pH	8.30	12.29	11.72	11.33	12.54	11.90	11.94

TABLE 2-11

SWMU 8 – Pretreatment, Phase I and Phase II, SPLP and pH Results (metals concentrations in mg/L)

	Pretreatment	**10% PC**	**8% PC**	**6% PC**	**10% FA**	**8% FA**	**6% FA**
Arsenic	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100
Barium	< 1.00	0.488	< 1.00	< 1.00	0.566	< 1.00	< 1.00
Cadmium	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Chromium	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Lead	2.81	20.0	17.9	6.17	0.0396	< 0.0500	< 0.0500
Mercury	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Selenium	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100
Silver	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
pH	8.43	12.39	11.99	12.07	11.51	11.16	10.83

	Pretreatment	**10% CKD**	**8% CKD**	**6% CKD**	**10% LKD**	**8% LKD**	**6% LKD**
Arsenic	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100
Barium	< 1.00	< 1.00	< 1.00	< 1.00	1.13	< 1.00	< 1.00
Cadmium	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Chromium	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
Lead	2.81	6.45	1.86	0.25	112	84.2	41.5
Mercury	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020	< 0.0020
Selenium	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100	< 0.100
Silver	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500	< 0.0500
pH	8.43	12.48	12.09	11.56	12.56	12.30	12.15

TABLE 2-12

SWMU 57 – Pretreatment, Phase I and Phase II, SPLP and pH Results (metals concentrations in mg/L)

	Pretreatment	**10% PC**	**8% PC**	**6% PC**	**10% FA**	**8% FA**	**6% FA**
Arsenic	0.305	0.0401	□ 0.100	□ 0.100	□ 0.100	0.153	0.173
Barium	□ 1.00	0.395	□ 1.00	□ 1.00	□ 1.00	□ 1.00	□ 1.00
Cadmium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Chromium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Lead	3.27	5.59	9.93	5.99	0.0637	□ 0.0500	□ 0.0500
Mercury	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020
Selenium	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Silver	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
pH	7.10	12.46	12.06	11.92	11.28	10.91	10.02

	Pretreatment	**10% CKD**	**8% CKD**	**6% CKD**	**10% LKD**	**8% LKD**	**6% LKD**
Arsenic	0.305	0.0544	0.105	0.139	□ 0.100	□ 0.100	□ 0.100
Barium	□ 1.00	0.557	□ 1.00	□ 1.00	0.622	□ 1.00	□ 1.00
Cadmium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Chromium	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
Lead	3.27	3.10	1.24	□ 0.0500	107	45.8	27.3
Mercury	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020	□ 0.0020
Selenium	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100	□ 0.100
Silver	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500	□ 0.0500
pH	7.10	12.36	12.01	11.09	12.58	12.47	11.99

2.7.2 Waste Handling

All investigation-derived waste (IDW) generated by the treatability study was disposed of in accordance with the TSWP and with TEAD's May 1994 Industrial Risk Management Policy Statement.

The soil sampling generated no waste. Material moved as part of surface soil sampling was used to backfill small depressions caused by sampling. Decontamination water was containerized in a 55-gallon drum and disposed of offsite. This water was analyzed for SPLP metals. Results of this analysis are presented in Table 2-13.

TABLE 2-13

Waste Water Analytical Results

WW062501	
	Decon Waste Water Concentration (mg/L)
Arsenic	□ 0.100
Barium	□ 1.00
Cadmium	□ 0.0500
Chromium	□ 0.0500
Lead	0.478
Mercury	□ 0.0020
Selenium	□ 0.100
Silver	□ 0.0500

Samples collected 6/25/01

Personal protective equipment (PPE) and unused sampling supplies were disposed of in a facility garbage bin. A copy of the decontamination water analytical results was sent for review to Dean Reynolds at TEAD. The decontamination water was determined to be non-hazardous, and was picked up for disposal by Safety Kleen on September 18, 2001. A copy of the hazardous waste manifest is provided in Appendix C.

3.0 EVALUATION OF REAGENT PERFORMANCE

This section presents an evaluation of the treatability study performance, and provides recommendations for the full-scale implementation of S/S for treating lead-contaminated soils at SWMUs 6 and 8. SWMU 57, a Group C SWMU, was evaluated because the lead-contaminated soil at the Skeet Range was a candidate for treatment using S/S.

The goal of the treatability study was to evaluate the performance of four different S/S reagents to treat lead-contaminated soil at SWMUs 6, 8, and 57. Site-specific performance criteria were established and approved by EPA, UDEQ, and USACE. Information from this report will be used in developing the RAWPs for the full-scale S/S remediation at SWMUs 6 and 8 only. The SWMU 57 CMWP will be handled separately.

The treated material was evaluated against physical and chemical performance criteria identified in Table 1-1. Of the four reagents tested – portland cement, Class C fly ash, cement kiln dust and lime kiln dust – lead was detected above the SPLP criterion of 75 mg/L in lime kiln dust mixtures in Phase I (10 percent, SWMU 8 and 57) and in Phase II (8 percent, SWMU 8). For this reason, lime kiln dust is not recommended as a viable reagent for full-scale treatment.

There appears to be differences between SWMU 6 and 8 soils when treated. Cement kiln dust mixtures at SWMU 6 perform better than at SWMU 8. Fly ash mixtures perform well at SWMUs 6 and 8. Portland Cement mixtures perform well at SWMUs 6 and 57, but not as well at SWMU 8.

Based on the Phase I and II results, the fly ash and portland cement meet most of the performance criteria presented in this study. The hydraulic conductivity result for the 6 percent fly ash mixture at SWMU 6 is just below the target range of 10^{-4} to 10^{-6}. However, SWMU 6 contains the most gravel of the three SWMUs, and the hydraulic conductivity will likely be increased if gravel from the site is added to the mixture in the full-scale application. The hydraulic conductivity limits are set to avoid ponding of water on the treated material, therefore, the RAWP should recommend grading the treated soil in such a way as to avoid ponding of water on the treated soil.

Table 3-1 presents the vendor information for the reagents used during the treatability study. The costs provided are on a per ton basis and do not include shipping costs. Assume that 300 and 2,800 yd^3 require treatment at SWMU 6 and 8, respectively. Therefore, approximately 4,340 tons of soil would require 260 tons of reagent at a 6 percent loading rate. A simple cost evaluation of the reagents identifies that cement kiln dust is the most economical reagent under the given assumptions. Transportation costs may contribute significantly to the total cost to use Class C fly ash for S/S at TEAD.

TABLE 3-1

Reagent Location and Cost Information

Reagent	Location	Estimated Cost (per ton)*
Portland Cement	Readily available	$75-80
Class C fly ash	ISG Resources, Inc. Glenrock, WY Dave Johnson Power Plant	$45-50
Cement kiln dust	Holcim US Morgan, UT Devil’s Slide Plant	$0-5
Lime kiln dust	Graymont Lime West Wendover, NV Pilot Peak	$5-10

* Shipping costs not included.

4.0 REFERENCES

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APPENDIX A

Field Notes

"Rite in the Rain"®
ALL-WEATHER WRITING PAPER

FIELD

All-Weather Notebook
No. 351

TOOELE ARMY DEPOT
TREATABILITY STUDY
6/01
URS/DAMES & MOORE

4 5/8" x 7" - 48 Numbered Pages

"Rite in the Rain"®
ALL-WEATHER WRITING PAPER

Name URS

TONY APANAVAGE / SARAH GETTIER

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STE 700 BETHESDA, MD. 20814

Phone 301 652 2215

Project TEAD, UTAH

TREATABILITY STUDY

6/01

Yellow Polyethylene Protective Slipcovers (Item #31) are available for this style of notebook. Helps protect your notebook from wear & tear. Contact your dealer or the J. L. Darling Corporation.

INCHES

CONTENTS

PAGE	REFERENCE	DATE
	URS/Dames & Moore 301 652 2215	
	FAX 301 656 8059	
	Reg. H+S Mgr	
	Patsy Ginsman 301 670 3332	
	HOSPITAL 435 843 3600	
	24 hr SECURITY 833 2314	
	EOD 833 2962	
	JAY WEYLAND 833 3702	
	(Engineering/Permits)	
	Larry McFarland 435 833 3504	
	(TEAD - Envir. Dept)	
	ONSITE EMERGENCY 911 or	
	435-833 4206	
	ONBASE UXO 435 833 2962	

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[signature] 6/18/01

18JUN01
SUNNY 80°

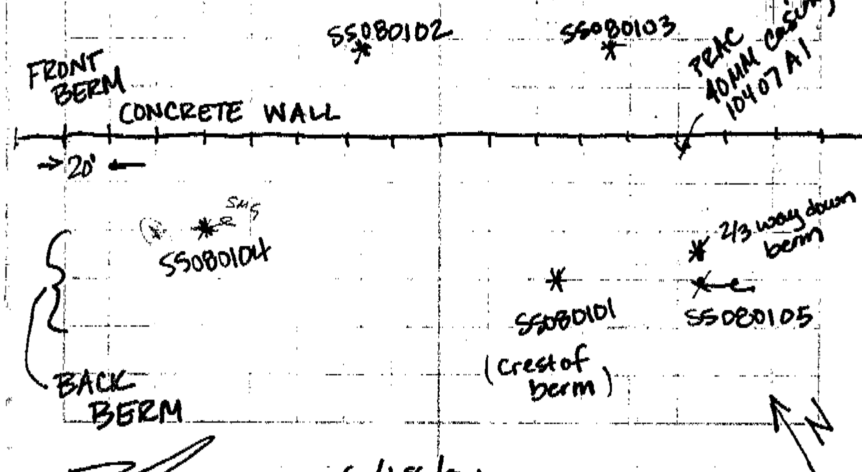
TEAD

10:00 TREATABILITY STUDY KICKOFF MEETING

ATTENDING: SARAH GETTIER
TONY APANAVAGE
BRYTON JOHNSON
EOTI (UXO COMPANY) < DAVE GUENTHNER
CLIFF WALDEN

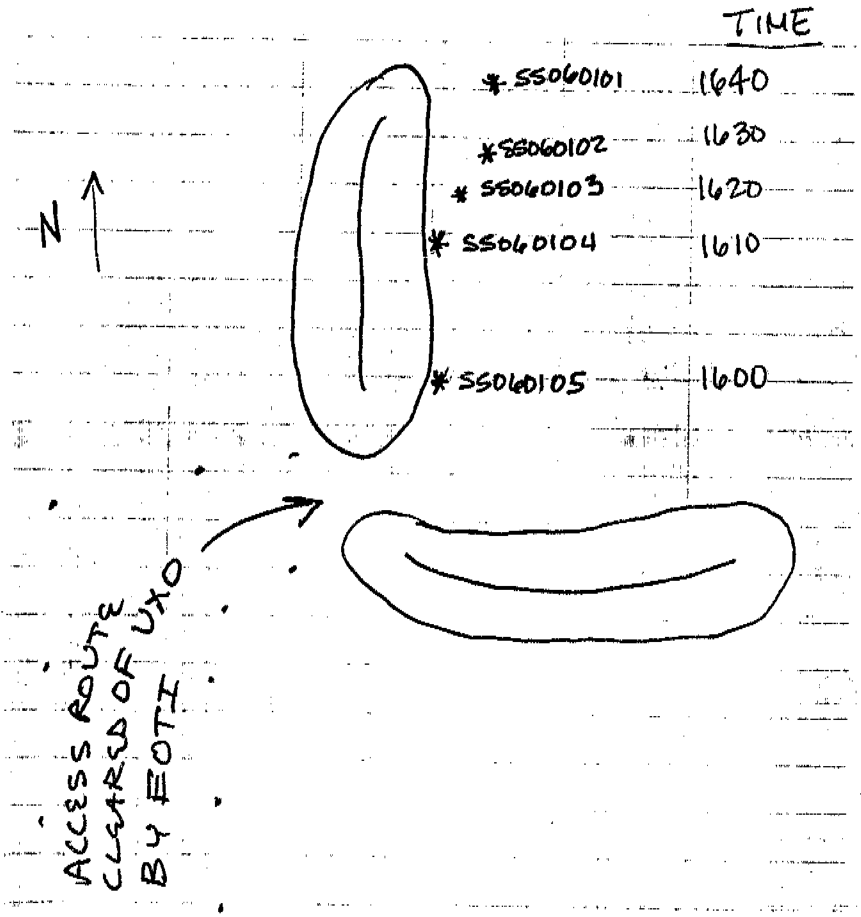
1200 SITE SAFETY BRIEFING

~~0115~~ SMG 1315 ARRIVE AT SWMU 8
0200 1400 MARK LOCATION OF SS0801051 SMG
~~0215~~ 1415 MARK LOCATION OF SS080105
~~0230~~ 1430 MARK LOCATION OF SS080104



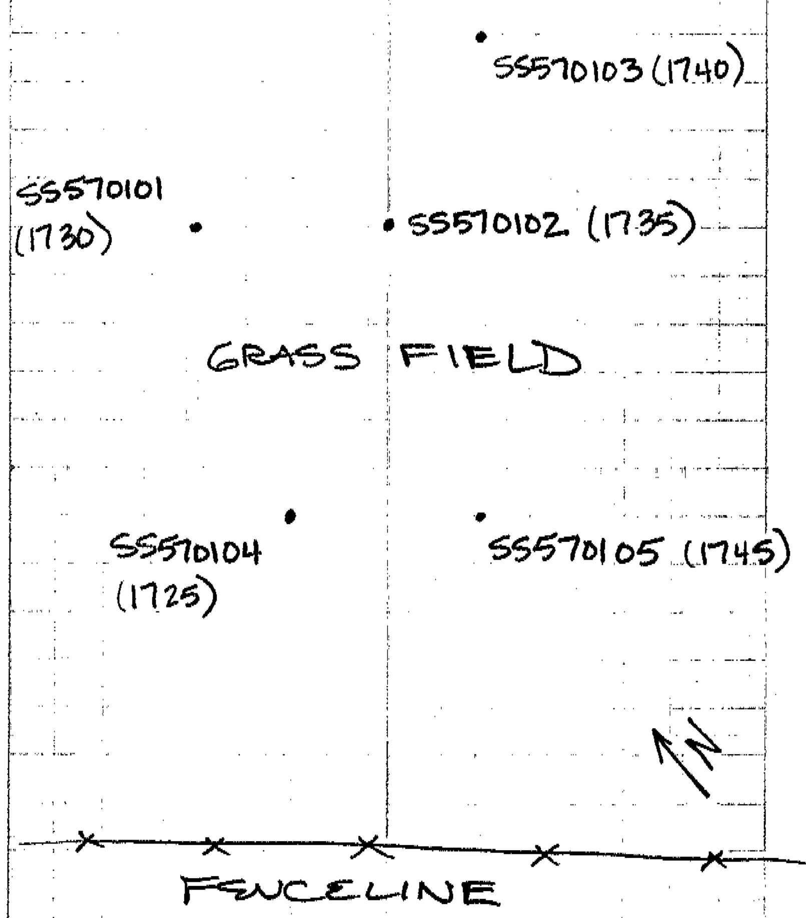
[signature] 6/18/01

1445 ~~0245~~ MARK LOCATION SS080103
1500 ~~0300~~ MARK LOCATION SS080102
1525 ~~0325~~ leave SWMU8 ~~SS080101~~ SMG
Carl Cole site visit
1540 ~~0340~~ ARRIVE AT SWMU6



6/18/01

1715 MOB to SWMU 57
Mark soil sample locations (TIME)



6/18/01

TEAD 6/18/01

1750 MOB to 90 day storage yard to put decon water into 55 gal drum

1800 OFFSITE

[signature] 6/18/01

TEAD

0830 Arrive at TEAD Building 8 Saw Dean Renolyds about 90 day Storage yard Key for Decon Water

0900 Place 55 gallon drum at 90 day yard on wooden pallate w/ label. H+S TAILGATE MEETING

0935 Arrive at SWMU 6

	SX ID	TIME
1000 Take Sample at	SS060105	1005
	SS060104	1020
	SS060103	1030
	SS060102	1040
(More surface gravel than other 4 locations) →	SS060101	1050

ALSO "SS060101B" RINSEATE OF TROWEL

SOIL LOG

SS060101 → Brown Silt, very fine grained, poorly graded, trace sand, much fine to coarse gravel, dry, some root matter.

SS060102 → 05 – SAME AS ABOVE BUT w/ LESS SURFACE GRAVEL

[signature] 6/19/01

TEAD 6/19/01

1100 DECON ALL EQUIPMENT, Bowls, Shovel, trowel etc....
(DI H_2O / LIQUINOX)

Samples immediately placed on ice and put in cooler.

LUNCH/GAS BREAK

1230 MET @ SITE @ WENT TO SWMU 8 TO SAMPLE.

ID	TIME
SS080101	1300
" 02	1310
" 03	1320
" 04	1340
" 05	1350

ALSO: "SS080102B" RINSEATE
"SS080105R" DUPLICATE
"SS080102M" MS
"SS080102S" MSD

LARRY McFarland / Carl (COE) visit site.

6/19/01

TEAD 6/19/01

1400 MOB. TO SWMU 57

ID	TIME
SS570101	1430
" 02	1440
" 03	1450
" 04	1500
" 05	1510

"SS570103B" RINSEATE

1630
PACKED SAMPLES ON ICE, FILLED OUT CHAIN-OF-CUSTODY, CUSTODY SEALS - SENT FEDEX NEXT BUSINESS MORNING DELIVERY
TRACKING # 8208 6467 8835

6/19/01

TEAD

6/20/01
TAPANAVAGE / S. GETTER

DOWN TIME — WAITING FOR LAB TO RETURN ANALYTICAL RESULTS - 24 HR TAT.
(H+S MEETING)
EXPECT RESULTS MORNING OF 6-21-01.

WENT BACK TO 3 SITES TO MARK SAMPLE LOCATIONS OFF PERMANENT STRUCTURES SEE FIGURES LATER IN THIS LOGBOOK.

6/20/01

TEAD

6/21/01
T. TAPANAVAGE
S. GETTER
SUNNY 80°F TO 90°F

WENT TO GET SUPPLIES IN MORNING WHILE WAITING FOR ANALYTICAL DATA FROM LAB.

RESULTS CALLED IN FROM LAB.
HEALTH + SAFETY MEETING
HIGHEST HITS OF LEAD WERE MUCH LOWER THAN EXPECTED.

	SAMPLE	LEAD (ppm)
SWMU 6 →	SS060102	300
SWMU 8 →	SS080105R	471
	SS080105	230
SWMU 57 →	SS570101	762

1200 CONFERENCE CALL W/ TEAD, COE, URS TO DECIDE FUTURE PLANS OF PROJECT.

"DUPLICATE" WAS HIGHEST LEAD CONC.
"DUPLICATE" WAS ALSO 2 TIMES LEAD CONC. AS SAME SAMPLE?

DUE TO RANDOMNESS OF LEAD IN SOIL SAMPLE WAS MIXED WELL AND COMPOSITED CORRECTLY. 6/21/01

TEAD 6/21/01

AFTER CONFERENCE CALL - DECIDED TO TAKE 2 BUCKET SAMPLES FROM HIGHEST LEAD CONC. SAMPLE @ EACH OF 3 SITES.

MAKING SURE WE DIG ALL THE WAY TO 2' BGS FOR SAMPLE AND GET LEADSHOT/MILITARY BULLETS AND ROUNDS IN BULK SAMPLES.

LAB WILL GRIND THESE SAMPLES BEFORE TAKING LEAD ANALYSIS.

LEAD SAMPLES LESS THAN EXPECTED POSSIBLY/PROBABLY DUE TO SURFACE SAMPLE (WIND-EROSION) HAS CHANGED SOIL @ SAMPLING LOCATION OVER THE YEARS PLUS TAKING COMPOSITE SAMPLES FROM 5 LOCATIONS COULD DILUTE SAMPLE (SAY IF ONE OR TWO WERE "HOT" AND THREE OR FOUR OF THE FIVE WERE "CLEAN")

6/21/01

TEAD 6/21/01

1330 Arrive at SWMU 6 to take sample.

AFTER RECEIVING FAX/CALL FROM LAB IT WAS DETERMINED THAT THE DATA ORIGINALLY PROVIDED TO US BY LAB ABOUT HIGHEST LEAD CONC. WAS WRONG. (LAB MISTAKE!)

THE PERSON WHO ORIGINALLY REPORTED DATA DID NOT ACCOUNT FOR DIGESTION AMT. INCLUDED OR % SOLIDS ETC., (RAW DATA)

↳ THEREFORE THE TRUE CONC. OF LEAD ARE ACTUALLY MUCH HIGHER.

SEE CHART NEXT PAGE.

6/21/01

14

TEAD 6/21/01

	ID	LEAD CONC.	
SWMU6	01	661	
	02	25600	*
	03	5550	
	04	489	
	05	879	
SWMU8	01	1130	
	02	17000	
	03	4530	
	04	1860	
	05	20300	
	05R (DUP.)	40200	*
SWMU57	01	67600	*
	02	372	
	03	121	
	04	164	
	05	136	

* DENOTES HIGHEST LEAD CONC.

SOIL LOG ⇒ SWMU 6 Darker brown soil
SWMU 8 Lighter brown soil

TEAD 6/21/01

TOOK BULK SAMPLE @ SWMU6
2, 5-gallon buckets.

NOTE: WILL ALSO TAKE 2 JARS FOR LEAD ANALYSIS FOR LAB. THESE WERE SAMPLES THAT WERE ORIGINALLY SUPPOSED TO BE SENT TO LAB FROM URS SOIL LAB IN AUSTIN, TX WHERE BULK SAMPLES ARE GOING. HOWEVER – URS SOIL LAB MOVED LOCATION AND LAB IS NOT FULLY SETUP AND RATHER THAN HAVE BULK SAMPLES SIT ON SHELF BEFORE LEAD ANALYSIS, WE TOOK THEM NOW.

SOIL LOG ⇒ AFTER APPROX 1' SOIL CHANGED TO BROWNISH-YELLOW IN COLOR – LESS ROOT MATTER – STILL MUCH GRAVEL.

[signature] 6/21/01

TEAD 6/21/01

% VOLUME OF GRAVEL>2"+
FROM BULK SAMPLES @ SWMU6
WAS APPROX
↳ 5 GALLONS GRAVEL
FOR 10 GALLONS OF
SOIL.

POUNDED PIECE OF REBAR FOR
PERMANENT MARKER WHERE WE
TOOK BULK SAMPLE.
↓
"BS060102"

(LATE LUNCH BREAK)

BACK ONSITE - WENT TO SWMU8
TO TAKE BULK SAMPLE. (1515)

SAMPLE "SS080105R" (DUPLICATE)
WAS THE HIGHEST LEAD CONC.

6/21/01

TEAD 6/21/01

* HOWEVER NOTICING THAT SAMPLE
LOCATION NUMBER 2 WAS HIGH
WE REVISITED THAT LOCATION.
WHILE DIGGING IN DIRT TO
INVESTIGATE WE FOUND THAT
THIS LOCATION WAS LITTERED
WITH MANY HANDGUN ROUNDS/
BULLETS. THE EOD TECH FROM
EOTI SAID THERE WAS
EVIDENCE THAT THERE WAS
A TARGET LOCATED PREVIOUSLY
AT OUR SAMPLING LOCATION
WHICH WOULD ACCOUNT FOR
THE ROUNDS/BULLETS PRESENT.

SAMPLE LOCATION #5 WAS
STILL THE HIGHEST LEAD CONC.
NO SOLID EVIDENCE OF LEAD
(ROUNDS/BULLETS ETC...) WERE
PRESENT @ #5 THOUGH - HIGH
CONC. OF LEAD @ #5 LOCATION
IS A MYSTERY.

6/21/01

TEAD 6/21/01

BASED ON THAT DATA WE DECIDED TO TAKE THE BULK SAMPLE FROM SWMU 8 AS A COMPOSITE SAMPLE FROM BOTH THE #2 AND #5 LOCATIONS. (1/2 SOIL IN EACH BUCKET FROM EACH OF #2/#5 LOCATIONS)

BS080105

ALSO TOOK 2 JARS FOR ANALYTICAL LEAD SAMPLE - THESE ARE COMPOSITES ALSO.

SAMPLES (ANALYTICAL) PUT ON ICE.

TOOK WASTEWATER TO 90 DAY STORAGE YARD IN DRUM.

OFFSITE - BACK TO HOTEL FOR CALLS TO COE/URS ETC... AND PAPERWORK.

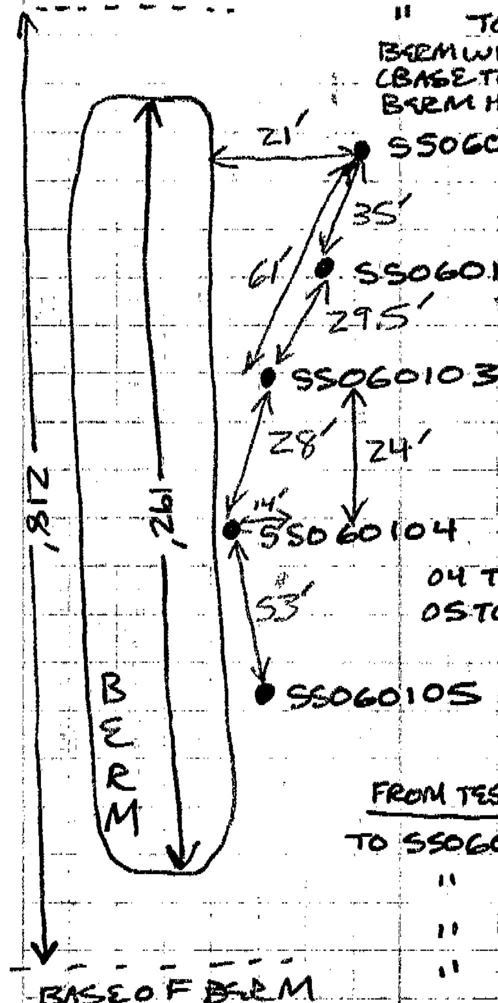
DEMOB 1800

1% GRAVEL REMOVED FROM BULK SAMPLE @ SWMU #8.

6/21/01

SWMU 61 TEAD 6/21/01

01 TO BOTTOM OF BERM 21'
" TOP " 36'
BERM WIDTH (BASE TO BASE) 26'
BERM HEIGHTH 5.5-6'



04 TO BASE OF BERM 2'
05 TO BASE OF BERM 3'

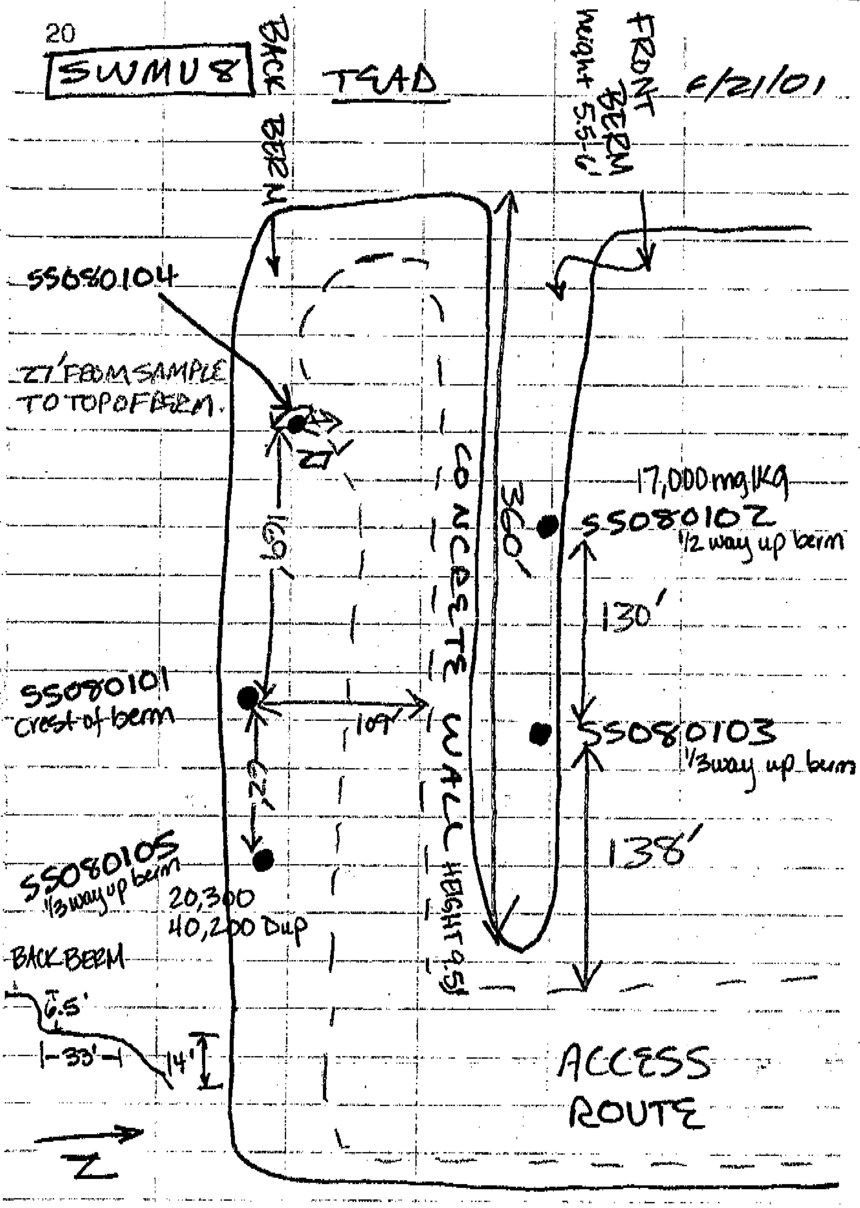
FROM TEST PIT 01 MARKER:

TO SS060102		35.5'
"	03	62.5'
"	04	88.5'
"	05	138'

TO SS060101 (CENTER) → 4.5'

6/21/01

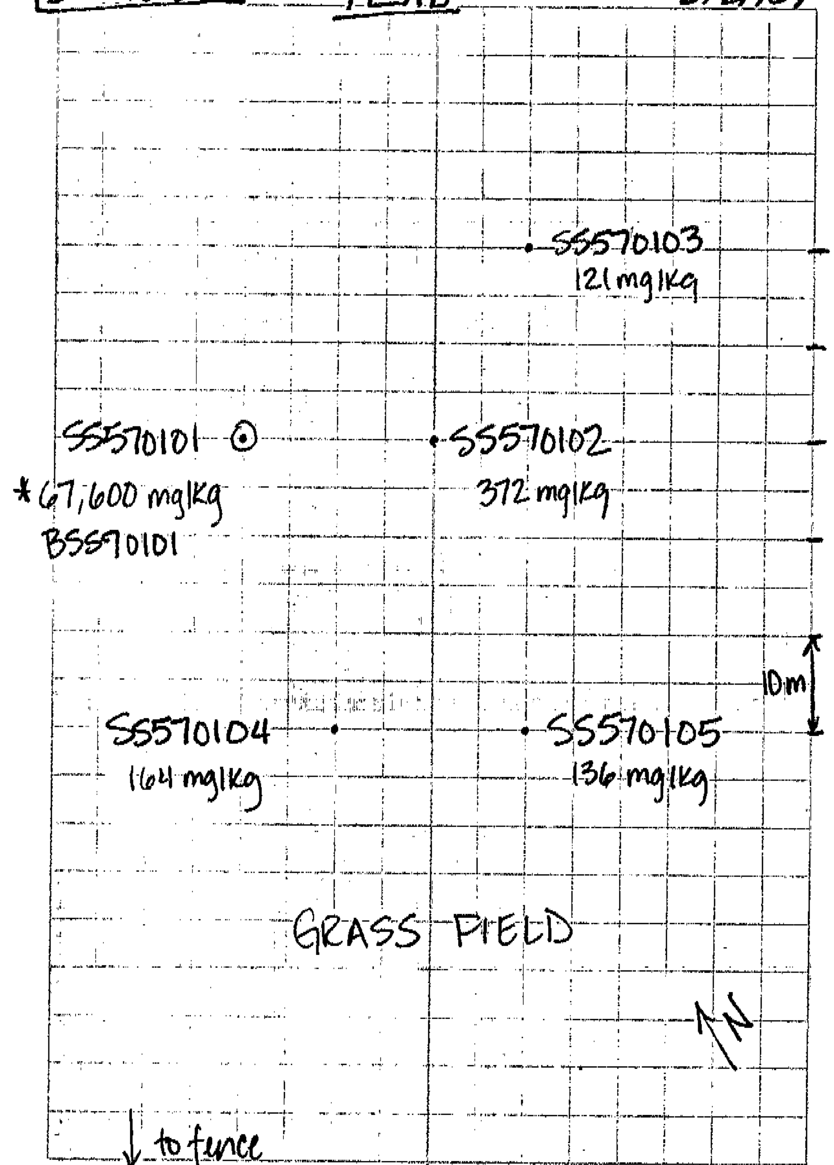
SWMU8 TEAD 6/21/01



CONCRETE WALL = 18 LENGTHS OF 20' EACH
360' TOTAL LENGTH.

6/21/01

SWMU57 TEAD 6/21/01



6/21/01

TEAD 6/22/01
sunny 90°F
T. Aparavage/S. Gettier

0700-0715 H+S TAILGATE MEETING.

MOBILIZE TO SWMU #8 TO POUND REBAR @ BOTH #2/#5 SAMPLING LOCATIONS. MEASURED DISTANCES TO PERMANENT STRUCTURES/TOOK MORE PICTURES.

WENT TO SEE DEAN REYNOLDS. TOLD US TO DECON 2 RUBBERMAID TUBS/REMOVE HAZ WASTE LABELS AND DISCARD AS TRASH.

0830 MOBILIZE TO SWMU 57
TOOK BULK SAMPLE AT "BS570101"
(BULK SAMPLES CONTAIN ANTS!)
SOIL LOG → Brown Silt, trace sand, some fine gravel, root matter, dry. (Far less gravel than SWMU #6) 0% VOLUME OF GRAVEL (REMOVED = NO GRAVEL REMOVED)
ALSO ADDED LEADSHOT FROM NEARBY ANTHILLS TO BULK SAMPLES.
6/21/01

TEAD 6/22/01
Sunny 94°
T. Aparavage / S. Gettier

0930 Mobilize to 90 day yard
Took wastewater to 55 gallon drum. Deconed Rubbermaid Tubs. Removed Haz. Waste labels from Rubbermaid tubs and discarded in dumpster.

1015 Met Chuck Laurence (Safety Kleen) to give him extra soil sample from SWMU 57. We kept a copy of the Material Profile for this sample.

Packaged 6 - 5gal bucket bulk samples and shipped to URS LAB.

Also packed up and sent other soil samples for Pb from the bulk samples.

6/21/01

TEAD 6/25/01

T. Apanavage
S. Gettier

SUNNY 74°

0745 Mob to 90 day storage yard to take waste water samples

2, 1L Bottles of waste water from 55 gallon drum

1, 1L Bottle of DI water

"WW062501"

"DW062501"

SAMPLES PUT ON ICE - SENT FEDEX OVERNIGHT TO SEVERN TRENT SERVICES LAB.

Returned Haz Waste Labels 2+3 to Dean Renolyds BACK TO ENVIRONMENTAL OFFICE TO TALK TO LARRY McFARLAND

RETURN HAMMER/REBAR TO CARL COLE (COE).

RETURNED KEY TO 90 DAY STORAGE YARD TO JULIE IN ENVIR. BUILDING.

6/25/01

TEAD 6/25/01

RETURNED SECURITY BADGES TO SECURITY OFFICE

TOOK SAMPLES (H_2O) + COOLERS FULL OF EQUIP (BACK TO URS OFFICE) TO MAILBOXES ETC... FOR SHIPMENT.

TOOK SARAH GETTIER TO AIRPORT. TONY A. WILL FLY BACK TO BWI TUESDAY

OFFSITE

6/25/01

PICTURE LOG | CAMERA #2

#1 SWMU 6 SS060102 location
material > 2" approximately 5gallon
#2 SWMU6 sample depth approx 2 feet
#3 SWMU6 75mm Cartridge case
200' to BERM (W/SW OF BERM)
#4 Ogive – Forward portion of
155mm highexpl. bullet
(Found same loc. as #3)
#5
#6 } SWMU8 HANDGUN ROUNDS
#7 SWMU8 5.56 mm M-16 round.
#8 SWMU8 Height of
② back berm + sample SS080105
#9 SWMU8 Height of back berm ①
#10 SWMU8 Height of front berm 60'
and sample SS080102
#11 SWMU8 target holders in front of #02
#12 SWMU8 general view of SWMU 8 facing NE
#13 SWMU 57 lead shot at hill
#13A SWMU-57-07
#14 SWMU57 BULK SX
#15 SWMU 57 general picture from 01
facing SW towards skeet range

PICTURE LOG CAMERA #1

#1 Sampling @ SWMU 6
#2 Sampling @ SWMU 6
#3 SWMU 6
#4 SWMU 6
#5 SWMU 8
#6 SWMU 8
#6A SWMU 8
#7 SWMU B RINSEATE SAMPLE
#8 SWMU 8 RINSEATE SAMPLE
#9 SWMU 8 "M781" ORDNANCE
40mm PRACTICE ROUND
#10 SWMU 8 3 - 40mm ROUNDS
#11 SWMU 8 VARIOUS ORDNANCE
M407 A-1
#12 SWMU 8 SLAP FLARE
#13 SWMU 8 "M781" NEWER VERSION
#14 SWMU 57 DECON BOWL
#15 SWMU 57
#16 SWMU 57 > SOIL SAMPLING
#14 A, B > SWMU 57 SITE
#17 SWMU 6 120 MM casing side view
#18 SWMU 7 120 MM casing base of cartridge
#19 DIGGING AT SS060102 6/21/01
#20 DECON DRUM 90 DAY STORAGE YARD

APPENDIX B

Photographic Log

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
USACE-Sacramento	Tooele Army Depot, Tooele, Utah	00109-051

Photo No.	Date:
1	6/01

Direction Photo Taken:

Facing North

Description:
SWMU 6:
View of SWMU 6

Photo No.	Date:
2	6/01

Direction Photo Taken:

Facing Northwest

Description:
SWMU 6:
Sampling at SWMU 6

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
USACE-Sacramento	Tooele Army Depot, Tooele, Utah	00109-051

Photo No.	Date:
3	6/21/01

Direction Photo Taken:

Toward ground surface

Description:
SWMU 6:
SS060102 location
-notice material >2-inches in diameter (approximately 5 gallons)

Photo No.	Date:
4	6/01

Direction Photo Taken:

Toward ground surface.

Description:
SWMU 6:
Ordance fragments found outside bermed area , approx. 200' to berm, W/SW of the berm
-"Ogive" Forward portion of 155mm high explosive bullet

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
USACE-Sacramento	Tooele Army Depot, Tooele, Utah	00109-051

Photo No.	Date:
5	6/01

Direction Photo Taken:

Toward ground surface

Description:
SWMU 6:
Ordance fragments found outside bermed area , approx. 200' to berm, W/SW of the berm
-75mm cartridge case

Photo No.	Date:
6	9/00

Direction Photo Taken:

Facing Northwest

Description:
SWMU 8:
Concrete wall behind first berm

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
USACE-Sacramento	Tooele Army Depot, Tooele, Utah	00109-051

Photo No.	Date:
7	6/01

Direction Photo Taken:

Facing Southwest

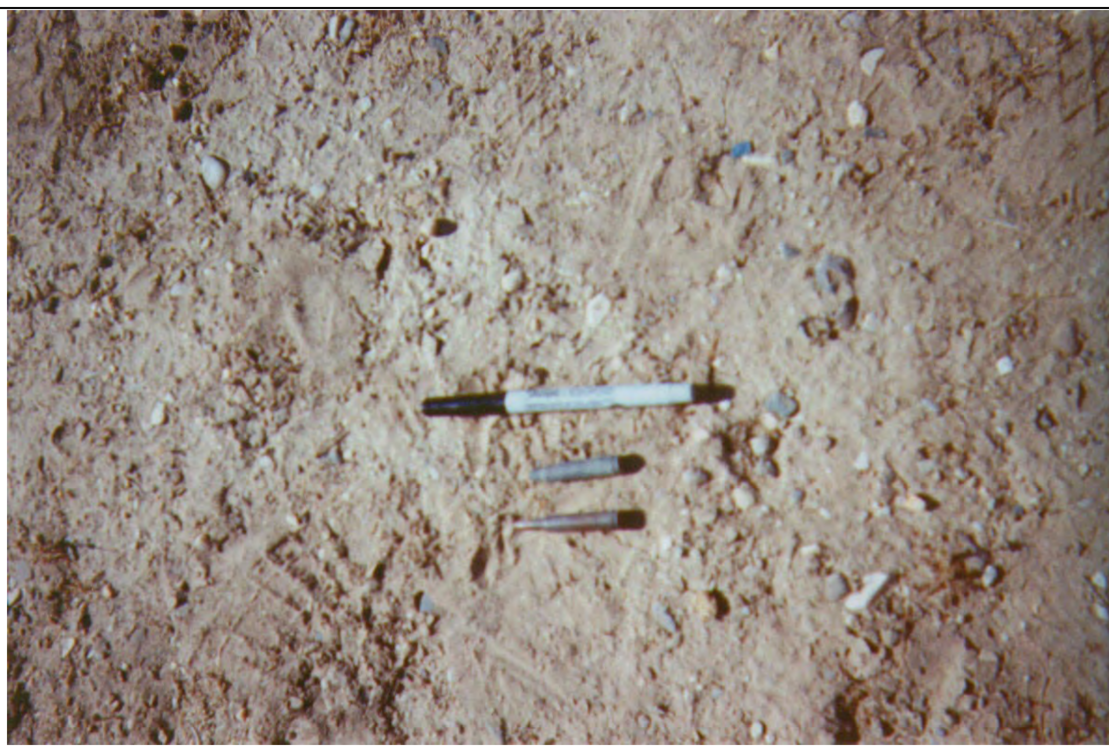
Description:
SWMU 8:
General view of SWMU 8 facing NE
Picture taken from top of surrounding berm

Photo No.	Date:
8	6/01

Direction Photo Taken:

Toward ground surface.

Description:
SWMU 8:
Ordance found on ground at SWMU 8
-5.56mm, one exploded, one not exploded



PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
USACE-Sacramento	Tooele Army Depot, Tooele, Utah	00109-051

Photo No. 9 **Date:** 6/01

Direction Photo Taken:

Toward ground surface

Description:
SWMU 8:
Ordance found on ground at SWMU 8
-Handgun rounds

Photo No. 10 **Date:** 6/01

Direction Photo Taken:

Toward ground surface.

Description:
SWMU 8:
Ordance found on ground at SWMU 8
-"M781" newer version of 40mm rounds

PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
USACE-Sacramento	Tooele Army Depot, Tooele, Utah	00109-051

Photo No.	Date:
11	6/01

Direction Photo Taken:

Toward ground surface

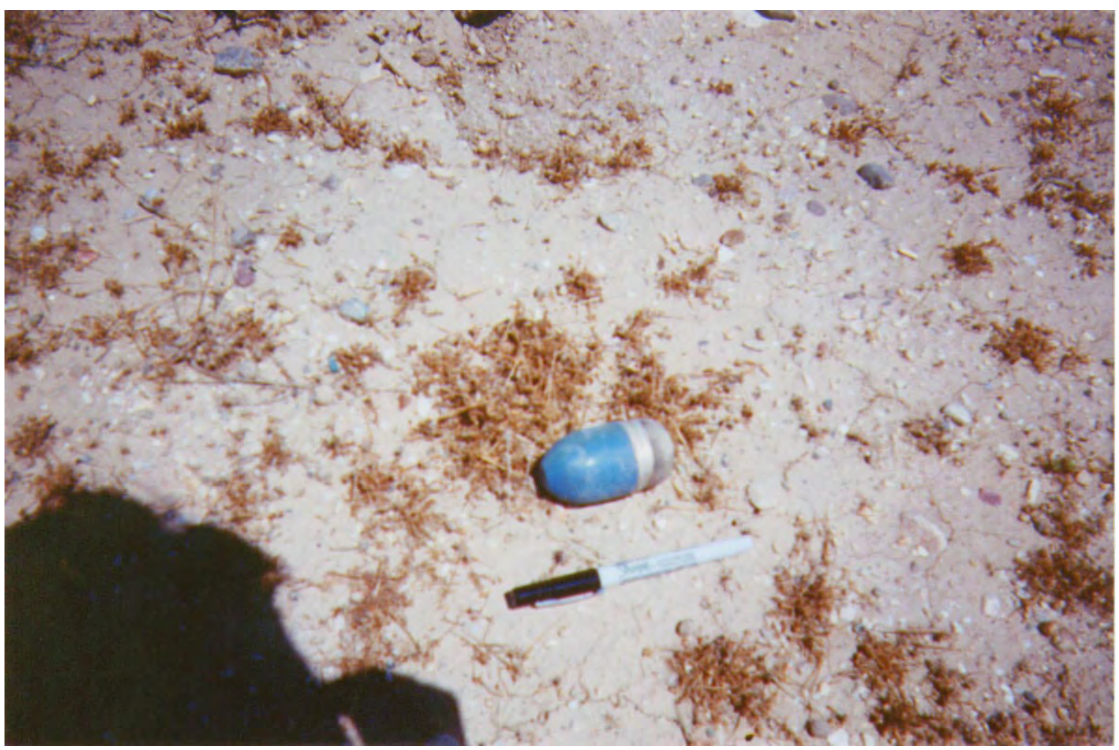
Description:
SWMU 8:
Ordance found on ground at SWMU 8
-Slap flare

Photo No.	Date:
12	6/01

Direction Photo Taken:

Toward ground surface.

Description:
SWMU 8:
Ordance found on ground at SWMU 8
-"M781" 40mm practice round



PHOTOGRAPHIC LOG

Client Name:	Site Location:	Project No.
USACE-Sacramento	Tooele Army Depot, Tooele, Utah	00109-051

Photo No.	Date:
13	6/01

Direction Photo Taken:

Toward skeet range.

Description:
SWMU 57:
General shot of SWMU 57 facing SW toward skeet range.

Photo No.	Date:
14	6/01

Direction Photo Taken:

Toward ground surface.

Description:
SWMU 57:
Ant hill containing visible lead shot. Stake from another study.

APPENDIX C

Hazardous Waste Manifest

Emergency Contact Telephone Number

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. UT3213820894 Manifest Document No. 01009
2. Page 1 of 1
Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
TOOELE ARMY DEPOT
COMMANDER TOOELE ARMY DEPOT BLDG 8, ATTN SMATE-CS-EO
TOOELE UTAH 84074
4. Generator's Phone (435) 833-3504 ATTN DEAN REYNOLDS

A. State Manifest Document Number
B. State Generator's ID

5. Transporter 1 Company Name: SAFETY KLEEN (TG) INC.
6. US EPA ID Number: SCR000074591
C. State Transporter's ID
D. Transporter's Phone 801-569-7605

7. Transporter 2 Company Name
8. US EPA ID Number
E. State Transporter's ID
F. Transporter's Phone

9. Designated Facility Name and Site Address
SAFETY KLEEN (GRASSY MTN) INC
3 MILES EAST 7 MILES NORTH OF I-80, EXIT 49
CLIVE UT,
10. US EPA ID Number: UTD991301748
G. State Facility's ID
H. Facility's Phone 801-323-8900

11. US DOT Description (Including Proper Shipping Name, Hazard Class, and ID Number)	HM	12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a. NON RCRA NON REGULATED MATERIAL		001	DF	00072	P	N/A
b.						
c.						
d.						

J. Additional Descriptions for Materials Listed Above
A. GM01-0600 (WATER (DECON)) EPA. N/A

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information
EMERGENCY PHONE # 435-833-2015

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

If I am a large quantity generator, I certify that I have a program in place to reduce the volume and toxicity of waste generated to the degree I have determined to be economically practicable and that I have selected the practicable method of treatment, storage, or disposal currently available to me which minimizes the present and future threat to human health and the environment; OR, if I am a small quantity generator, I have made a good faith effort to minimize my waste generation and select the best waste management method that is available to me and that I can afford.

Printed/Typed Name: Merle D Reynolds — Signature: Merle D Reynolds — Month Day Year: 09 20 01

GENERATOR

17. Transporter 1 Acknowledgement of Receipt of Materials
Printed/Typed Name: MARSHALL KEELING — Signature — Month Day Year: 09 20 01

18. Transporter 2 Acknowledgement of Receipt of Materials
Printed/Typed Name — Signature — Month Day Year

TRANSPORTER

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.

Printed/Typed Name — Signature — Month Day Year

FACILITY

ORIGINAL - RETURN TO GENERATOR

SK REFERENCE NO. 2345...

safety-kleen.

MATERIAL PROFILE

Safety-Kleen (SK) Use Only	If applicable, Intercompany Billing Facility #	Customer Number:	SK Line Of Business #:	Facility Profile #:

A. GENERATOR INFORMATION

☐ Check if Billing Information is same as Generator Information

Generator Name: TOOELE ARMY DEPOT
Billing Company: URS / DAMES + MOORE

Facility Address (No P.O. Box): Commander Tooele Army Depot, Building 8, ATTN: SDSTE-IRE
Billing Address: 7101 Wisconsin Ave, Suite 700

City/State/Zip: Tooele, UT 84074-5000
City/State/Zip: Bethesda, MD 20814-4870

Technical Contact: Dean Reynolds / Larry McFarland
Billing Contact: Rosa Gwinn

Phone: 435-833-3504 Fax: 435-833-2839
Phone: 301-652-2215 Fax: 301-656-8059

Generator Location (If different from Facility Address): ______

SIC Code: ______ ☐ CESQG ☐ SQG US EPA ID # UT3213820894 State Generating ID # UT3213820894

B. SHIPPING INFORMATION

☐ DOT Assistance Requested ☒ Check if SK Transportation Services are requested

US DOT Proper Shipping Name: Non-Regulated Liquid

Hazard Class / Division # ______ ID # (UN/NA) ______ Packing Group (PG) ______ RQ ______

Non-Bulk Shipping Containers

Size		Steel	Poly	Fiber	Quantity	Frequency
55	Gal	☐	☒	☐	1 DRUM	
	Gal	☐	☐	☐		
	Gal	☐	☐	☐		
	Gal	☐	☐	☐		

Bulk Shipping Containers

Container Type	Quantity & Size	Frequency
☐ Yd.³ Box or ☐ Super Sack		
☐ Hard Top or ☐ Tarped Bin		
☐ End Dump (Tarped) Trailer		
☐ Tank or ☐ Vacuum Trailer		

C. GENERAL MATERIAL & REGULATORY INFORMATION

Name of Material: Water (Decon)

Process Generating The Material: Decontamination of Soil sampling equipment

Odor: ☒ None ☐ Mild ☐ Strong; Describe ______

Yes	No	
☐	☒	Regulated or Licensed Radioactive Waste
☐	☒	Regulated Medical / Infectious Waste
☐	☒	Waste Subject To Benzene NESHAP Regulations
☐	☒	TSCA Regulated PCB Waste (List any PCB level in Sec. D)
☐	☒	Regulated Subpart CC Waste (VOs ≥ 500 ppm)
☐	☒	Regulated Ozone Depleting Substance
☐	☒	CERCLA Regulated (Superfund) Waste
☐	☒	Hazardous Debris (Subject to alternative LDR treatment standards)
☐	☒	Waste Contains UHCs/Constituents of Concern

If Yes, list in ☐ Sec. D or ☐ Constituent Addendum

Yes	No	
☐	☐	Meets LDR Standards or ☐ Partially Meets (For Landfill Only)
☐	☒	Commingled Waste (Two or more hazardous wastes mixed at one)
☐	☒	Sorbent Added; If Yes, is sorbent biodegradable? ☐ Yes ☐ No
☐	☒	Exempt Waste; If Yes, list reference 40 CFR ______
☐	☒	State Hazardous Waste; State Code ______
☐	☒	EPA Hazardous Waste

EPA Waste Codes (including any LDR subcategories, e.g., D003 Water Reactive): None

EPA Haz Waste Only Origin Code: ☐1 ☐2 ☐3 ☐4 ☐5 Source Code: A ______ Form Code: B ______ System Code: M ______

D. MATERIAL COMPOSITION

1. Chemical / Physical Constituents: List all detectable components by chemical name, including physical material, e.g., sorbent, debris.

Chemical Constituents & Composition	ppm	☐ wt % ☐ vol %	Chemical Constituents & Composition	ppm	☐ wt % ☐ vol %
Water (Decon)		100			
Lead	0.478				

Section D continues on the next page for Elemental Constituents

Range Total ≥ 100%

ORIGINAL

SK REFERENCE NO.
2345429

Note: Completion of Sections D.2 & F is optional for: ☐ Analytical Profile (representative sample submitted; test results used to complete D.2 & F)
Completion of Sections D.2, E & F is optional for: ☐ Standard Industry Profile (Safety-Kleen Corp. historical data utilized to complete D.2, E, & F)

D. MATERIAL COMPOSITION (Continued)

2. Elemental Constituents ☐ *Check if this waste contains No Detectable Elements / Metals, unless listed below.* SEE ATTACHED ANALYTICAL

Check either: ☑ Total Analysis or ☐ TCLP Method or ☐ Generator Knowledge, then enter data below.

Constituent	ppm	Constituent	ppm	Constituent	ppm	Constituent	ppm	Constituent	ppm
Aluminum		Cadmium	ND	Fluorine		Nickel		Sodium	
Antimony		Chlorine		Lead	0.478	Phosphorous		Sulfur	
Arsenic	ND	Chromium	ND	Lithium		Potassium		Thallium	
Barium	ND	Cobalt		Manganese		Selenium	ND	Titanium	
Beryllium		Copper		Mercury		Silicon		Vanadium	
Bromine		Iodine		Molybdenum		Silver	ND	Zinc	

E. REACTIVE CHARACTERISTICS ☒ *Check if this waste exhibits No Reactive Characteristics*

Yes No		Yes No		Yes No	
☐ ☐	Explosive	☐ ☐	Oxidizer	☐ ☐	Reactive Cyanide ______ ppm
☐ ☐	Shock Sensitive	☐ ☐	Water Reactive	☐ ☐	Reactive Sulfide ______ ppm
☐ ☐	Pyrophoric	☐ ☐	Air Reactive	☐ ☐	Polymerizable
☐ ☐	Other Incompatibles; Describe				

F. MATERIAL PHYSICAL CHARACTERISTICS @ 70° F.

# of Phases	1	Color	Clear	Flash Point NA °F (if < 73 °F)	pH ☑ Liquids > 20% H_2O or pH ☐ Non-Aqueous
Liquid %	100	Specific Gravity	~1.000	☐ 73 - <100°F ☐ 100 - 141°F	☐ ≤ 2 pH ☐ > 2 - 4 pH ☑ > 4 - 10 pH
Sludge %	0	Viscosity cps		☐ 142°F - <200° F ☐ ≥200° F	☐ > 10 - < 12.5 pH ☐ ≥ 12.5 pH
Solid %	0	Density		Boiling Point (if < 130°F)	BTU's / lb. or Range
Powder %	0	☐ lbs./gal. ☐ lbs./cu. ft.		Ash % (Bridgeport Only)	
Gas %	0	Comments			

G. GENERATOR PROFILE CERTIFICATION

I hereby certify that I am an authorized agent of the generator, and warrant on behalf of the generator that the information supplied on this form and on any attachments or supplements hereto is complete and accurate, and that all known or suspected hazards of the material(s) described herein have been disclosed. I agree that if the sample test results indicate a discrepancy with any information supplied on this form, that either Safety-Kleen or the generator may initiate further testing and evaluation in accordance with the terms and conditions of the contract between Safety-Kleen and the generator and that this profile certification may be amended accordingly.

Merle D Reynolds — Generator's Authorized Signature
Merle D Reynolds — Name & Title (Printed or Typed)
08 / 28 / 01 — Date

Comments

Safety-Kleen Use Only ☐ SKOS ☐ SKVS ☐ Non-haz Evaluation ☐ Standard Industry Profile: SIP Index # ______

SK Sales Rep. Name ______ Rep.# ______ Territory/Branch # ______

Process Approval # ______ Product Code or Part # ______ TRI Flowpath # ______ Pricing ______

Waste Approval & Certification

I certify acceptability of this waste stream and that all appropriate permits have been obtained, as indicated by Safety-Kleen's facility approval below.

Safety-Kleen's Authorized Facility Signature ______ Name & Title (Printed or Typed) ______ Date __ / __ / __

ORIGINAL

APPENDIX D

Phase I and II Laboratory Results

TOOELE TREATABILITY STUDY
INITIAL BUCKET CHARACTERIZATION RESULTS

SWMU	TOTAL WEIGHT (g)	GRAVEL WEIGHT (g)	GRAVEL %	WASTE HT. (ft)	BUCKET DIA. (ft)	VOLUME (ft3)	VOLUME (cm3)	BULK DENSITY (g/cm3)
6A	31747			0.96	0.92	0.638170565	18070.98	1.76
6B	30243			0.975	0.92	0.64814198	18353.34	1.65
6 avg.	30995	5987.8	19%					1.70
8A	31296			1.02	0.92	0.678056226	19200.42	1.63
8B	30197			1.01	0.92	0.671408616	19012.18	1.59
8 avg.	30747	1317	4%					1.61
57A	23804.5			0.945	0.92	0.62819915	17788.62	1.34
57B	23109.5			0.94	0.92	0.624875345	17694.5	1.31
57 avg.	23457	766.5	3%					1.32

TOOELE TREATABILITY STUDY

PHASE 1 LAB PENETROMETER RESULTS

			DAY 2				DAY 4/5				DAY 7				DAY 10				DAY 14			
SWMU	Mix	Start Date	Date	Lbs Force	Needle Area (in2)	lbs/in2	Date	Lbs Force	Needle Area (in2)	lbs/in2	Date	Lbs Force	Needle Area (in2)	lbs/in2	Date	Lbs Force	Needle Area (in2)	lbs/in2	Date	Lbs Force	Needle Area (in2)	lbs/in2
6	10% PC	7/16/2001	7/18/2001	>200	0.05	4000	7/20/2001	>200	0.025	8000	7/23/2001	>200	0.025	8000	7/26/2001	>200	0.025	8000	7/30/2001	>200	0.025	8000
	10% FA	7/16/2001	7/18/2001	64	0.05	1280	7/20/2001	72	0.05	1440	7/23/2001	72	0.05	1440	7/26/2001	72	0.025	2880	7/30/2001	100	0.025	4000
	10% CKD	7/16/2001	7/18/2001	140	0.05	2800	7/20/2001	150	0.025	6000	7/23/2001	>200	0.05	4000	7/26/2001	160	0.025	6400	7/30/2001	>200	0.025	8000
	10% LKD	7/16/2001	7/18/2001	>200	0.05	4000	7/20/2001	180	0.025	7200	7/23/2001	>200	0.05	4000	7/26/2001	168	0.025	6720	7/30/2001	>200	0.025	8000
8	10% PC	7/16/2001	7/18/2001	170	0.05	3400	7/20/2001	102	0.025	4080	7/23/2001	>200	0.05	4000	7/26/2001	170	0.025	6800	7/30/2001	160	0.025	6400
	10% FA	7/17/2001	7/19/2001	175	0.05	3500	7/22/2001	84	0.025	3360	7/24/2001	154	0.025	6160	7/27/2001	>200	0.025	8000	7/31/2001	>200	0.025	8000
	10% CKD	7/17/2001	7/19/2001	90	0.05	1800	7/22/2001	175	0.05	3500	7/24/2001	120	0.025	4800	7/27/2001	160	0.025	6400	7/31/2001	160	0.025	6400
	10% LKD	7/16/2001	7/18/2001	71	0.05	1420	7/20/2001	102	0.05	2040	7/23/2001	111	0.05	2220	7/26/2001	120	0.025	4800	7/30/2001	120	0.025	4800
57	10% PC	7/17/2001	7/19/2001	>200	0.05	4000	7/22/2001	>200	0.025	8000	7/24/2001	>200	0.025	8000	7/27/2001	>200	0.025	8000	7/31/2001	>200	0.025	8000
	10% FA	7/17/2001	7/19/2001	148	0.05	2960	7/22/2001	60	0.025	2400	7/24/2001	64	0.025	2560	7/27/2001	168	0.025	6720	7/31/2001	160	0.025	6400
	10% CKD	7/17/2001	7/19/2001	65	0.05	1300	7/22/2001	140	0.05	2800	7/24/2001	72	0.025	2880	7/27/2001	180	0.025	7200	7/31/2001	154	0.025	6160
	10% LKD	7/17/2001	7/19/2001	105	0.05	2100	7/22/2001	180	0.05	3600	7/24/2001	68	0.025	2720	7/27/2001	110	0.025	4400	7/31/2001	118	0.025	4720

Note: shaded values are actually > than the value shown

PHASE 1 UNCONFINED COMPRESSIVE STRENGTH RESULTS

				DAY 7				
SWMU	**Mix**	**Rep**	**Start Date**	**Date**	**Lbs Force**	**Surface Area (in2)**	**lbs/in2**	**Avg. lbs/in2**
6	10% PC	A	7/16/2001	7/23/2001	2880	7.07	407	463
		B	7/16/2001	7/23/2001	3670	7.07	519	
	10% FA	A	7/16/2001	7/23/2001	416	7.07	59	61
		B	7/16/2001	7/23/2001	453	7.07	64	
	10% CKD	A	7/16/2001	7/23/2001	801	7.07	113	127
		B	7/17/2001	7/24/2001	1001	7.07	142	
	10% LKD	A	7/16/2001	7/23/2001	1447	7.07	205	200
		B	7/16/2001	7/23/2001	1385	7.07	196	
8	10% PC	A	7/16/2001	7/23/2001	2535	7.07	359	397
		B	7/16/2001	7/23/2001	3080	7.07	436	
	10% FA	A	7/17/2001	7/24/2001	1071	7.07	152	164
		B	7/17/2001	7/24/2001	1251	7.07	177	
	10% CKD	A	7/17/2001	7/24/2001	1307	7.07	185	183
		B	7/17/2001	7/24/2001	1281	7.07	181	
	10% LKD	A	7/16/2001	7/23/2001	1288	7.07	182	158
		B	7/16/2001	7/23/2001	951	7.07	135	
57	10% PC	A	7/17/2001	7/24/2001	992	7.07	140	135
		B	7/17/2001	7/24/2001	915	7.07	129	
	10% FA	A	7/17/2001	7/24/2001	921	7.07	130	145
		B	7/17/2001	7/24/2001	1122	7.07	159	
	10% CKD	A	7/17/2001	7/24/2001	541	7.07	77	87
		B	7/17/2001	7/24/2001	691	7.07	98	
	10% LKD	A	7/17/2001	7/24/2001	2670	7.07	378	451
		B	7/17/2001	7/24/2001	3710	7.07	525	

PHASE 1 UNIT WEIGHT RESULTS

SWMU	Mix	Rep	Start Date	Wt (g)	Ht (in)	Vol (in3)	Vol (cm3)	Unit Wt. (g/cm3)	Avg. Unit Weight (g/cm3)
6	10% PC	A	7/16/2001	1501.1	6.0	42.4	695.0	2.16	2.13
		B	7/16/2001	729.4	3.0	21.2	347.5	2.10	
	10% FA	A	7/16/2001	785.5	3.0	21.2	347.5	2.26	2.21
		B	7/16/2001	747.0	3.0	21.2	347.5	2.15	
	10% CKD	A	7/16/2001	801.7	3.0	21.2	347.5	2.31	2.23
		B	7/17/2001	751.5	3.0	21.2	347.5	2.16	
	10% LKD	A	7/16/2001	747.2	3.0	21.2	347.5	2.15	2.17
		B	7/16/2001	764.1	3.0	21.2	347.5	2.20	
8	10% PC	A	7/16/2001	781.3	3.0	21.2	347.5	2.25	2.32
		B	7/16/2001	833.6	3.0	21.2	347.5	2.40	
	10% FA	A	7/17/2001	781.2	3.0	21.2	347.5	2.25	2.25
		B	7/17/2001	785.3	3.0	21.2	347.5	2.26	
	10% CKD	A	7/17/2001	776.4	3.0	21.2	347.5	2.23	2.23
		B	7/17/2001	776.9	3.0	21.2	347.5	2.24	
	10% LKD	A	7/16/2001	749.5	3.0	21.2	347.5	2.16	2.16
		B	7/16/2001	754.1	3.0	21.2	347.5	2.17	
57	10% PC	A	7/17/2001	756.6	3.0	21.2	347.5	2.18	2.17
		B	7/17/2001	748.6	3.0	21.2	347.5	2.15	
	10% FA	A	7/17/2001	757.2	3.0	21.2	347.5	2.18	2.17
		B	7/17/2001	752.2	3.0	21.2	347.5	2.16	
	10% CKD	A	7/17/2001	752.6	3.0	21.2	347.5	2.17	2.16
		B	7/17/2001	750.0	3.0	21.2	347.5	2.16	
	10% LKD	A	7/17/2001	719.9	3.0	21.2	347.5	2.07	2.08
		B	7/17/2001	723.2	3.0	21.2	347.5	2.08	

TOOELE TREATABILITY STUDY

PHASE 2 LAB PENETROMETER RESULTS

			DAY 4/5				DAY 7				DAY 14/15			
SWMU	Mix	Start Date	Date	Lbs Force	Needle Area (in2)	lbs/in2	Date	Lbs Force	Needle Area (in2)	lbs/in2	Date	Lbs Force	Needle Area (in2)	lbs/in2
6	6% PC	8/8/2001	8/13/2001	>200	0.05	4000	8/15/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
	6% FA	8/8/2001	8/13/2001	120	0.05	2400	8/15/2001	160	0.05	3200	8/23/2001	180	0.05	3600
	6% CKD	8/8/2001	8/13/2001	>200	0.05	4000	8/15/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
	6% LKD	8/8/2001	8/13/2001	>200	0.05	4000	8/15/2001	150	0.025	6000	8/23/2001	>200	0.025	8000
8	6% PC	8/8/2001	8/13/2001	>200	0.05	4000	8/15/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
	6% FA	8/8/2001	8/13/2001	132	0.05	2640	8/15/2001	140	0.05	2800	8/23/2001	160	0.05	3200
	6% CKD	8/8/2001	8/13/2001	136	0.05	2720	8/15/2001	170	0.05	3400	8/23/2001	180	0.025	7200
	6% LKD	8/8/2001	8/13/2001	174	0.05	3480	8/15/2001	185	0.05	3700	8/23/2001	150	0.025	6000
57	6% PC	8/8/2001	8/13/2001	>200	0.05	4000	8/15/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
	6% FA	8/8/2001	8/13/2001	>200	0.05	4000	8/15/2001	160	0.025	6400	8/23/2001	>200	0.025	8000
	6% CKD	8/8/2001	8/13/2001	>200	0.05	4000	8/15/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
	6% LKD	8/8/2001	8/13/2001	>200	0.05	4000	8/15/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
6	8% PC	8/9/2001	8/13/2001	>200	0.05	4000	8/16/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
	8% FA	8/9/2001	8/13/2001	177	0.05	3540	8/16/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
	8% CKD	8/9/2001	8/13/2001	>200	0.05	4000	8/16/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
	8% LKD	8/9/2001	8/13/2001	>200	0.05	4000	8/16/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
8	8% PC	8/9/2001	8/13/2001	>200	0.05	4000	8/16/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
	8% FA	8/9/2001	8/13/2001	>200	0.05	4000	8/16/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
	8% CKD	8/9/2001	8/13/2001	>200	0.05	4000	8/16/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
	8% LKD	8/9/2001	8/13/2001	>200	0.05	4000	8/16/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
57	8% PC	8/9/2001	8/13/2001	>200	0.05	4000	8/16/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
	8% FA	8/9/2001	8/13/2001	>200	0.05	4000	8/16/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
	8% CKD	8/9/2001	8/13/2001	>200	0.05	4000	8/16/2001	>200	0.025	8000	8/23/2001	>200	0.025	8000
	8% LKD	8/9/2001	8/13/2001	>200	0.05	4000	8/16/2001	196	0.025	7840	8/23/2001	>200	0.025	8000

Note: shaded values are actually > than the value shown

PHASE 2 UNCONFINED COMPRESSIVE STRENGTH RESULTS

SWMU	Mix	Start Date	Date	Lbs Force	Surface Area (in2)	lbs/in2
6	6% PC	08/08/01	08/17/01	3339	7.07	472
	6% FA	08/08/01	08/17/01	492	7.07	70
	6% CKD	08/08/01	08/17/01	1256	7.07	178
	6% LKD	08/08/01	08/17/01	1187	7.07	168
8	6% PC	08/08/01	08/17/01	3900	7.07	552
	6% FA	08/08/01	08/17/01	1157	7.07	164
	6% CKD	08/08/01	08/17/01	921	7.07	130
	6% LKD	08/08/01	08/17/01	1000	7.07	141
57	6% PC	08/08/01	08/17/01	2610	7.07	369
	6% FA	08/08/01	08/17/01	799	7.07	113
	6% CKD	08/08/01	08/17/01	950	7.07	134
	6% LKD	08/08/01	08/17/01	407	7.07	58

SWMU	Mix	Start Date	Date	Lbs Force	Surface Area (in2)	lbs/in2
6	8% PC	08/09/01	08/17/01	2890	7.07	409
	8% FA	08/09/01	08/17/01	475	7.07	67
	8% CKD	08/09/01	08/17/01	989	7.07	140
	8% LKD	08/09/01	08/17/01	848	7.07	120
8	8% PC	08/09/01	08/17/01	3770	7.07	533
	8% FA	08/09/01	08/17/01	1405	7.07	199
	8% CKD	08/09/01	08/17/01	1062	7.07	150
	8% LKD	08/09/01	08/17/01	771	7.07	109
57	8% PC	08/09/01	08/17/01	3310	7.07	468
	8% FA	08/09/01	08/17/01	1068	7.07	151
	8% CKD	08/09/01	08/17/01	896	7.07	127
	8% LKD	08/09/01	08/17/01	612	7.07	87

PHASE 2 UNIT WEIGHT RESULTS

SWMU	Mix	Rep	Start Date	Wt (g)	Ht (in)	Vol (in3)	Vol (cm3)	Unit Wt. (g/cm3)	Total Additive Ratio	Avg. Volume Change (%)
6	6% PC	A	8/8/2001	737.4	3.0	21.2	347.5	2.12	0.14	-0.09
	6% FA	A	8/8/2001	774.6	3.0	21.2	347.5	2.23	0.14	-0.13
	6% CKD	A	8/8/2001	777.1	3.0	21.2	347.5	2.24	0.14	-0.13
	6% LKD	A	8/8/2001	737.4	3.0	21.2	347.5	2.12	0.14	-0.09
8	6% PC	A	8/8/2001	742.3	3.0	21.2	347.5	2.14	0.14	-0.14
	6% FA	A	8/8/2001	743.4	3.0	21.2	347.5	2.14	0.13	-0.15
	6% CKD	A	8/8/2001	737.0	3.0	21.2	347.5	2.12	0.13	-0.14
	6% LKD	A	8/8/2001	747.0	3.0	21.2	347.5	2.15	0.14	-0.15
57	6% PC	A	8/8/2001	734.1	3.0	21.2	347.5	2.11	0.14	-0.29
	6% FA	A	8/8/2001	738.2	3.0	21.2	347.5	2.12	0.13	-0.30
	6% CKD	A	8/8/2001	717.7	3.0	21.2	347.5	2.07	0.13	-0.28
	6% LKD	A	8/8/2001	739.0	3.0	21.2	347.5	2.13	0.14	-0.29

SWMU	Mix	Rep	Start Date	Wt (g)	Ht (in)	Vol (in3)	Vol (cm3)	Unit Wt. (g/cm3)	Total Additive Ratio	Avg. Volume Change (%)
6	8% PC	A	8/9/2001	736.5	3.0	21.2	347.5	2.12	0.16	-0.07
	8% FA	A	8/9/2001	750.1	3.0	21.2	347.5	2.16	0.16	-0.09
	8% CKD	A	8/9/2001	785.2	3.0	21.2	347.5	2.26	0.16	-0.13
	8% LKD	A	8/9/2001	724.1	3.0	21.2	347.5	2.08	0.16	-0.05
8	8% PC	A	8/9/2001	734.3	3.0	21.2	347.5	2.11	0.16	-0.12
	8% FA	A	8/9/2001	776.3	3.0	21.2	347.5	2.23	0.16	-0.16
	8% CKD	A	8/9/2001	733.4	3.0	21.2	347.5	2.11	0.16	-0.12
	8% LKD	A	8/9/2001	738.0	3.0	21.2	347.5	2.12	0.16	-0.12
57	8% PC	A	8/9/2001	734.1	3.0	21.2	347.5	2.11	0.16	-0.27
	8% FA	A	8/9/2001	734.7	3.0	21.2	347.5	2.11	0.16	-0.27
	8% CKD	A	8/9/2001	726.1	3.0	21.2	347.5	2.09	0.16	-0.27
	8% LKD	A	8/9/2001	734.5	3.0	21.2	347.5	2.11	0.16	-0.27

Avg. Initial Bulk Density	
6	1.70
8	1.61
57	1.32

TITLE Tooele Pb Soils

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SWMU-6

6% PC OMC

HT= 2.933" (7.45 cm) Dia = 3.0" (7.62 cm) Wt= 719.09 g

Surface Area = 45.604 cm^2

1646 started overnight leachate run
2 psi core pressure
10 psi confining pressure

9/21/01

total- 576.38 (g)

1.283

0830 took sample of leachate approx 400-500 mls. Wt (g) = 2.292

0845 started permeability readings on SWMU-6 2 psi core/10 psi conf

SWMU-6
6% PC

P_1 = 2.0 psig (140.62 Kpa) P_2 = 140.62 Kpa P_3 = 140.62 Kpa
T_1 = 0:18:00 (1080 sec) T_2 = 0:21:00 (1260 sec) T_3 = 0:24:00 (1440 sec
V_1 = 19.6 ml V_2 = 20.9 ml V_3 = 24.2 ml

2.09×10^{-5} cm/s 1.92×10^{-5} cm/s 1.95×10^{-5} cm/s

Average: 1.99×10^{-5} cm/s

Tare flask - 318

9/24/01 9 psi Core/18 psi Confine

SWMU-8 Sat Volume = 33.5 mls Start time 1015

6% PC OMC

HT = 7.6 cm/2.992" Dia = 3.0" (7.62 cm) Surface Area 45.604 cm

Wt: 762.55 g

P_1 = 9 psi (632.79 kPa) P_2 = 632.79 kPa P_3 = 632.79 kPa
T_1 = 20:00 (1200 sec) T_2 = 12:00 (720 sec) T_3 = 28:00
V_1 = 10.4 mls V_2 = 6.3 mls V_3 = 13.2 mls

2.28×10^{-6} cm/s 2.30×10^{-6} cm/s 2.07×10^{-6} cm/s

avg = 2.22×10^{-6} cm/s

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STS REPORT
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~~1715~~ 1545 Started runs on SWMU-57. Will get sample in AM after pressure equilizes. SWMU-8 will run over night due to very slow leaching process.

SWMU-57 = 493.43 g   SWMU 6 - 576.38 g
SWMU-8 = 539.87 g

SWMU-57   Tare flasks 318.70(g)   Sat Volume = 49 mls
67% PC OMC
Ht = 75.66 mm 2.976" (7.56 cm)   Dia = 3.0" (7.62 cm)   Surf Area = 45.604 cm^2
Wt = 710.90(g)

P_1 = 24 psi (1687.44 kpa)
T_1 = 15:00 (900 sec)
V_1 = 12.6 mls
1.38 x 10^{-6} cm/s

P_2 = 1687.44 kpa
T_2 = 20:00 (1200 sec)
V_2 = 12.9
1.06 x 10^{-6} cm/s

P_3 = 1687.44 kpa
T_3 = 25:00 (1500 secs)
V_3 = 17.5 mls
1.15 x 10^{-6} cm/s

P_4 : 1687.44 kPa
T_4 : 10:00 (600 sec)
V_4 = 9.7 mls
1.58 x 10^{-6} cm/s

Avg = 1.29 x 10^{-6} cm/s

Ran 4th time due to irregular pattern of time/volume. T4 seems to be right in-line.

DP

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10/29/01

SWMU-6
8% FA
8% H_2O

10/30/01 - Still running

11/2/01 -
11/1/01 - still running
10/31/01 - still running

flask + samp = ~~818.3~~ 592.9g
Tare Flasks = 346.2 g
total samp = ~~472.1~~ 246.7

Ht = 7.50 cm
Diameter = 7.62 cm (3.0")
Wt = 716.3 g

Sat Volume = 39 mls
Surf Area = 45.604 cm²

[10/30/01]

P_1 = 60 psi (4218.60 Kpa)
T_1 = 60:00 (3600 sec)
V_1 = 2.1 mls
= 2.27 x 10⁻⁸ cm/s

P_2 = 4218.60 Kpa
T_2 = 30:00 (1800 sec)
V_2 = 1.4 mls
= 3.0~~3~~ x 10⁻⁸ cm/s

P_3 = 4218.60 kpa
T_3 = 45:00 (2700 s
V_3 = 1.9
= 2.74 x 10⁻⁸ cm

Avg = 2.68 x 10⁻⁸ cm/s   * see add'l readings pag

SWMU-8
8% FA
8% H_2O

Tare Flasks = 346.2 g

flask + samp = 818.3
tot samp = 472.1

Ht = 7.51 cm
Dia = 7.62 cm
Wt = 728.1 g

Sat Vol = 43 mls
Surf Area = 45.604 cm²

P_1 = 64 psi (4499.84 Kpa)
T_1 = 15:00 (900 sec)
V_1 = 10.4 mls
= 4.~~06~~ 22 x 10⁻⁷ cm/s

P_2 = 4499.84 Kpa
T_2 = 20:00 (1200 sec)
V_2 = 14.3 mls
= 4.36 x 10⁻⁷ cm/s

P_3 = 4499.84 Kpa
T_3 = 25:00 (1500 sec
V_3 = 17.4
= 4.25 x 10⁻⁷ cm/s

Avg = 4.28 x 10⁻⁷ cm/s

- removed 10 core volumes, then began readings.
Sample bottled + preserved. 1645 (472.1 mls total)

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Additional Readings

10/30/01

SWMU-57 8% FA
8% H_2O

Ht = 7.50 cm
SA = 45.604 cm^2

P_1 - 60 psi (4218.6 Kpa)
T_1 - 20:00 (1200 sec)
V_1 - 13.2 mls
= 4.29×10^{-7} cm/s

P_2 - 4218.6 Kpa
T_2 - 40:00 (2400 sec)
V_2 - 25.7 mls
= 4.17×10^{-7} cm/s

P_3 - 4218.6 Kpa
T_3 - 60:00 (3600 sec)
V_3 - 37.0 mls
= 4.01×10^{-7} cm/s

10/31/01

SWMU-6 8% FA
8% H_2O

Ht = 7.50 cm
SA = 45.604 cm^2

P_1 - 60 psi (4218.6 Kpa)
T_1 - 15:00 (900 sec)
V_1 - 0.6 mls
= 2.60×10^{-8} cm/s

P_2 - 4218.6 Kpa
T_2 - 30:00 (1800 sec)
V_2 - 0.9 mls
= 1.95×10^{-8} cm/s

P_3 - 4218.6 Kpa
T_3 - 60:00 (3600 sec)
V_3 - 1.9 mls
= 2.06×10^{-8} cm/s

P_4 = 4218.6 Kpa
T_4 = 90:00 (5400 sec)
V_4 = 3.0 mls
= 2.17×10^{-8} cm/s

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Page No.__ 10/30/01

NMU-57
8% FA
8% H_2O

flask + samp - 816.0
Tare Flasks - 346.2g (469.8 mls total)
Ht = 7.50 cm
Sat Vol = 44 mls
Diameter = 7.62 cm
Surf Area 45.604 cm^2
Wt = 731.6 g

P_1 = 46 psi (3234.26) P_2 = 46 psi (3234.26 kpa) P_3 = 3234.26 Kpa
T_1 = 30:00 (1800 sec) T_2 = 15:00 (900 sec) T_3 = 45:00 (2700 sec)
V_1 = 14.9 mls V_2 = 8.2 mls V_3 = 21.7 mls
$= 4.21 \times 10^{-7}$ cm/s $= 4.63 \times 10^{-7}$ cm/s $= 4.09 \times 10^{-7}$ cm/s

Avg = 4.31×10^{-7} cm/s *see add'l page

NMU-6 10/31/01
6% FA
8% H_2O

flask + sample - 773.1
Tare flasks - 346.2 g Total sample - 426.9 mls
Ht = 7.80 cm
Sat Vol = 42 mls
Diam = 7.62 cm
Surf Area = 45.604 cm^2
Wt = 774.1 g

P_1 = 30 psi (2109.30 Kpa) P_2 = 2109.30 Kpa P_3 = 2109.30 Kpa
T_1 = 15:00 (900 sec) T_2 = 30:00 (1800 sec) T_3 = 60:00 (3600 sec)
V_1 = 8.8 ~~0.6~~ mls V_2 = 16.8 mls V_3 = 33.4 mls
$= 7.21 \times 10^{-7}$ cm/s $= 7.57 \times 10^{-7}$ cm/s $= 7.52 \times 10^{-7}$ cm/s

P_4 = 2109.30 Kpa
T_4 = 90:00 (5400 sec)
V_4 = 48.3 mls
$= 7.25 \times 10^{-7}$ cm/s

Avg = 7.39×10^{-7} cm/s

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11/1/01

flasks + samp = 1349.5 g   Tare flasks - 346.2 g   Tot = 1004.3 mls ~~436.9 ml~~ JP

SWMU - 8   6% FA   7% H_2O

Ht = 7.70 cm   Sat Vol = 48 mls

Dia = 7.62 cm   Surf Area = 45.604 cm^2

Wt = 738.6 g

P_1 - 14 psi (984.34 Kpa) P_2 = 984.34 Kpa P_3 - 984.34 Kpa

T_1 - 10:00 (600 sec) T_2 = 15:00 (900 sec) T_3 - 20:00 (1200 sec)

V_1 - 9.5 mls V_2 = 14.3 mls V_3 - 18.8 mls

= 2.70×10^{-6} cm/s   = 2.73×10^{-6} cm/s   = 2.69×10^{-6} cm/s

P_4 - 984.34 Kpa P_5 - 984.34 KPa

T_4 - 30:00 (1800 sec) T_5 - 60:00 (3600 sec)

V_4 - 28.3 mls V_5 - 56.4 mls

= 2.70×10^{-6} cm/s   = 2.69×10^{-6} cm/s

Avg = 2.70×10^{-6} cm/s

tare flasks - 346.2 g   flask + samp = 1069.7 g   total samp = 72

SWMU - 57   6% FA   7% H_2O

Ht = 7.50 cm   Sat Vol =

Dia = 7.62 cm   Surf Area = 45.604 cm^2

Wt = 719.8 g

P_1 - 8 psi (562.48 Kpa) P_2 = 562.48 Kpa P_3 = 562.48 Kpa

T_1 - 5:00 (300 sec) T_2 - 15:00 (900 sec) T_3 = 30:00 (1800 sec)

V_1 - 2.8 mls V_2 - 8.2 mls V_3 = 15.7 mls

= 2.73×10^{-6} cm/s   = 2.66×10^{-6} cm/s   = 2.55×10^{-6} cm/s

P_4 = 562.48 Kpa P_5 = 562.48 Kpa

T_4 = 60:00 (3600 sec) T_5 = 90:00 (5400 sec)

V_4 = 34.1 mls V_5 = 50.4

= 2.76×10^{-6} cm/s   = 2.73×10^{-6} cm/s

Avg = 2.69×10^{-6} cm/s

To Page No.

Witnessed & Understood by me,	Date	Invented by STS REPORT D-15	Date
		Recorded by	

APPENDIX E

Reagent Information

What's Fly Ash?

Fly ash closely resembles volcanic ashes used in production of the earliest known hydraulic cements about 2,300 years ago. Those cements were made near the small Italian town of Pozzuoli - which later gave its name to the term "pozzolan."

A pozzolan is a siliceous or siliceous / aluminous material that, when mixed with lime and water, forms a cementitious compound. Fly ash is the best known, and one of the most commonly used, pozzolans in the world.

Instead of volcanoes, today's fly ash comes primarily from coal-fired electricity generating power plants. These power plants grind coal to a powder fineness before it is burned. Fly ash - the mineral residue produced by burning coal - is captured from the power plant's exhaust gases and collected for use.

The difference between fly ash and portland cement becomes apparent under a microscope. Fly ash particles are almost totally spherical in shape, allowing them to flow and blend freely in mixtures. That capability is one of the properties making fly ash a desirable admixture for concrete.

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FLY ASH FOR CONCRETE QUALITY BUILDING MATERIALS SPECIALTY PRODUCTS CORPORATE
FLY ASH BASED TECHNOLOGIES UTILITY/INDUSTRIAL SERVICES CONTACT US ABOUT US

Utah

Under Utah law, fly ash, bottom ash, slag, and flue gas emission control waste are exempt from regulation as hazardous waste. These materials are also exempt from regulation as solid waste unless the waste causes a public nuisance or public health hazard or test results indicate the material is hazardous. Under Utah law, CCBs may be used for road sanding, sand blasting, road construction, railway ballast, construction fill, aggregate, and other construction-related purposes.

Contact Information:
Ralph Bohn
Utah Department of Environmental Quality
288 North 1460 West, P.O. Box 144880, Salt Lake City, UT 84114-4880
Phone: (801) 538-6170
Email: rbohn@deq.state.ut.us
Website: www.deq.state.ut.us

Detailed Review of CCB Regulations:
Under Utah law, fly ash, bottom ash, slag and flue gas emission control waste are exempt from regulation as hazardous waste. UAC 315-2-4. Fly ash, bottom ash, slag and flue gas emission control waste are also exempt from regulation as solid waste unless the waste causes a public nuisance or public health hazard or test results indicate the materials is hazardous. UTAH CODE ANN. §19-6-102(16)(b)(iii).

Under Utah law, CCPs may be reused in the following applications:

- Road sanding;
- Sand blasting;
- Road construction;
- Railway ballast;
- Construction fill;
- Aggregate; and
- Other construction-related purposes.

UTAH CODE ANN. §19-6-102.1.

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Related Plants

Cricket Mountain Plant

Indian Creek Plant

Tacoma Plant

Contact Us

Pilot Peak Plant

Graymont Western U.S. Inc.

The Pilot Peak plant is located 15 miles west of Wendover, Nevada, on Interstate 80 and the Union Pacific Mainline. A 450 ton per day coal fired preheater rotary kiln was placed in service on October 1, 1989. A second 650 ton per day kiln was commissioned in October 1993. A third kiln was brought into production in May 1996 with a capacity of 1,200 tons per day, making Pilot Peak the second largest plant in our system. In March 1994 a state of the art hydration plant was brought into service and is capable of producing 300 tons per day. The quarry is located on one of the largest and purest limestone deposits in the Western U.S.. The stone is quarried immediately adjacent to the plant, crushed to size and conveyed directly to the preheater kilns. The raw material is processed in a modern, fully computerized plant which is controlled by the latest quality assurance technologies. These technologies allow us to provide our customers with a reliable supply of the highest quality lime available. A full range of sized bulk quicklime products is available. Storage and shipping facilities are available for truck and rail delivery to customers.

Related Companies

Graymont Dolime (OH) Inc.

Graymont Western Canada Inc.

Graymont (PA) Inc.

Graymont (Portneuf) Inc.- English

Graymont Materials (QC) Inc.

Graymont Limited

Graymont (QC) Inc.- Français

Graymont (QC) Inc.- English

Graymont Western U.S. Inc.

Graymont (NB) Inc.

Graymont Materials (NY) Inc.

Graymont Inc.

Graymont (Portneuf) Inc.- Français

[Asphalt Concrete] [Stabilized Base]

KILN DUSTS **Material Description**

ORIGIN

Kiln dusts are fine by-products of Portland cement and lime high-temperature rotary kiln production operations that are captured in the air pollution control dust collection system (e.g., cyclones, electrostatic precipitators, and baghouses).

Cement Kiln Dust

Cement kiln dust (CKD) is a fine powdery material similar in appearance to Portland cement. Fresh cement kiln dusts can be classified as belonging to one of four categories, depending on the kiln process employed and the degree of separation in the dust collection system.(1) There are two types of cement kiln processes: wet-process kilns, which accept feed materials in a slurry form; and dry-process kilns, which accept feed materials in a dry, ground form. In each type of process the dust can be collected in two ways: (1) a portion of the dust can be separated and returned to the kiln from the dust collection system (e.g., cyclone) closest to the kiln, or (2) the total quantity of dust produced can be recycled or discarded. A simplified schematic of a Portland cement manufacturing operation is presented in Figure 8-1.

The chemical and physical characteristics of CKD that is collected for use outside of the cement production facility will depend in great part on the method of dust collection employed at the facility. Free lime can be found in CKD, and its concentration is typically highest in the coarser particles captured closest to the kiln. Finer particles tend to exhibit higher concentrations of sulfates and alkalis. If the coarser particles are not separated out and returned to the kiln, the total dust will be higher in free lime (since it will contain some coarse particles). CKD from wet-process kilns also tends to be lower in calcium content than dust from dry-process kilns.

Approximately 12.9 million metric tons (14.2 million tons) of CKD are produced annually.(2)

Lime Kiln Dust

Lime kiln dust (LKD) is physically similar to cement kiln dust, but chemically quite different. LKD can vary chemically depending on whether high-calcium lime (chemical lime, hydrated lime, quicklime) or dolomitic lime is being manufactured.

Fresh LKD can be divided into two categories based on relative reactivity, which is directly related to free lime and free magnesia content. Free lime and magnesia content are most dependent on whether the feedstock employed is calcitic or dolomitic limestone. LKD with a high free lime content IS highly reactive, producing an exothermic reaction upon addition of water. This "quick" LKD is of greatest commercial interest as a direct replacement or substitute for hydrated lime.

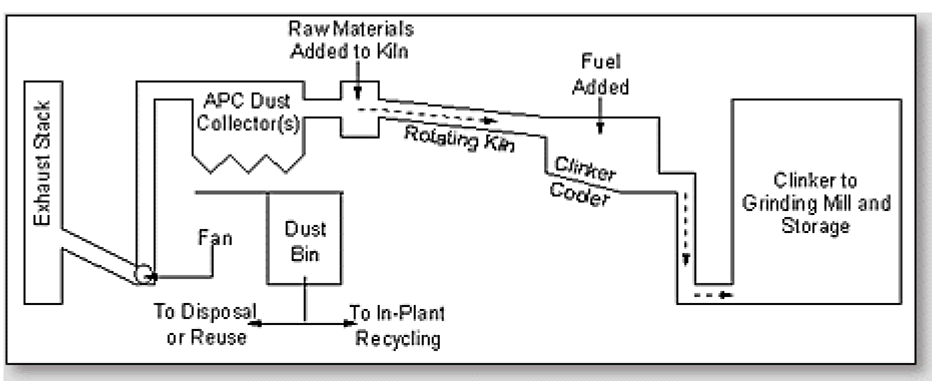

Figure 8-1. Portland cement manufacturing operations.

Approximately 1.8 to 3.6 million metric tons (2 to 4 million tons) of LKD are generated each year in the United States.[3]

In addition to fresh CKD and LKD production, it is estimated that the total amount of kiln dust currently stockpiled throughout the country exceeds close to 90 million metric tons (100 million tons). These stockpiles are usually located relatively close to the cement and lime manufacturing plants, and vary in age and composition, with exposure to the elements (moisture in particular) reducing the chemical reactivity of the dusts.

CURRENT MANAGEMENT OPTIONS

Recycling

Most of the CKD produced is reused within the cement plant. About 64 percent of the total CKD generated (or about 8.3 million metric tons) is used in this fashion.[2] Approximately 6 percent of the total CKD generated is utilized off-site. The most common beneficial use of CKD is its use as a stabilizing agent for wastes, where its absorptive capacity and alkaline properties can reduce the moisture content, increase the bearing capacity, and provide an alkaline environment for waste materials.

Both cement and lime kiln dusts have been used as stabilizing and solidifying agents in the treatment of soft or wet soils for engineering purposes[4] and for environmental remediation.[5] Both dusts have also been used as pozzolan initiators,[6] as a pelletized lightweight aggregate material, as a mineral filler in asphalt pavements, and as a fill material in earth embankments.

A significant potential market for CKD and LKD exists for its use as a soil conditioner for agricultural purposes (in lieu of agricultural lime) and as an acid-neutralizing agent in agricultural and water treatment applications. However, at the present time, the EPA is evaluating the possible need to regulate the use of CKD in this application.

In recent years hazardous waste has been used as a fuel in cement kiln operations. The use of waste materials in cement kiln operations has raised concerns regarding the accumulation of heavy metals (e.g., lead, cadmium, and chromium) in CKD generated by plants that use these alternative materials.[2] In addition, runoff and precipitation that contact CKD storage piles have exhibited pH levels above 12.5, which can be highly corrosive.[7] The EPA has expressed concern over uncontrolled transport, storage, and disposal of large volumes of CKD (in uncovered and unlined piles), which are easily removed by wind and eroded by water.

In a recent regulatory determination, the EPA committed to the development of revised standards for managing CKD.[7] In this regulatory determination, EPA stated, with respect to beneficial uses, that "for most off-site uses (e.g., waste stabilization or certain construction uses) EPA’s current record indicates that there are no significant risks." This would not preclude the need to examine the chemical quality of CKD prior to its use.

Disposal

At the present time, approximately 80 percent of the surplus CKD remaining after reuse in cement manufacturing is stockpiled or landfilled.[2] Most of the LKD generated in the United States is currently disposed of in stockpiles or landfills.[3]

MARKET SOURCES

Kiln dusts may be obtained directly from Portland cement or hydrated lime producers. Waste management firms retained by the manufacturers may also supply cement and lime kiln dusts.

The specific characteristics of the CKD and LKD vary from plant to plant depending on the feedstock employed at the cement or lime production plant, the major products being manufactured, kiln design and operation, fuel type, and the type of dust control/collection systems employed.

The primary value of cement and lime kiln dusts is their cementitious properties. Depending on the concentration of hydratable oxides present in the CKD and LKD, primarily unreacted or free lime (CaO) and free magnesia (MgO) respectively, cement kiln dust and lime kiln dust can be highly cementitious.

Fresh CKD and LKD are generally difficult to handle in bulk because of their fine, dry, powdery nature and caustic characteristics. The addition of water to mitigate blowing and dusting problems during transport is common, but this practice causes premature hydration of the free lime or magnesia and significantly reduces the cementitious potential of the CKD or LKD. Where the CKD or LKD must be kept dry to preserve its cementitious potential, it must be handled in a fashion that is similar to conventional cement or lime (pneumatically loaded into and unloaded from cement tanker trucks and stored in silos).

The processing of stockpiled CKD and LKD can be difficult. Typically, very large, above- ground stockpiles or backfilled quarries (source of raw product for cement manufacture) are involved, representing many years of cement or lime production. The surface of the stockpile or fill site usually crusts over and becomes hard, while the interior of the stockpile can stay relatively loose and can contain some unhydrated material even after many years if exposure to moisture is limited. Processing of hardened stockpiled kiln dusts requires crushing and screening equipment to remove oversize pieces as well as any litter or garbage (wood, etc.) that may have become mixed with the kiln dusts.

HIGHWAY USES AND PROCESSING REQUIREMENTS

Asphalt Concrete Mineral Filler

CKD and LKD have been used as mineral filler in asphalt concrete mixes. The blending of CKD into the asphalt cement binder prior to incorporation with the hot mix aggregate results in a binder (mastic) that can significant-ly reduce asphalt cement requirements (between 15 and 25 percent by volume).[(8)] Further, the lime components of the CKD and LKD can assist in promoting stripping resistance (preventing moisture-related damage resulting from the separation of the asphalt cement film from the aggregate at its interface in the presence of moisture that is most common in siliceous aggregates). In this application, these dusts can be used to replace hydrated lime or liquid antistripping agents.

CKD can also be used as a replacement for Portland cement or hydrated lime in slurry seals (mix of fine aggregate and emulsified asphalt). Slurry seal mixes with 2 percent kiln dust prepared in the laboratory, using a stripping fine aggregate gave excellent results in abrasion resistance testing.[(9)]

Asphalt Concrete Aggregate

CKD and LKD can also be agglomerated or pelletized to produce an artificial aggregate for special applications. In Japan an oil-absorbing artificial aggregate is reportedly manufactured using CKD that is used to improve the rutting resistance of asphalt concrete pavements by absorbing the lighter fractions of excess asphalt cement binder during hot weather.

Asphalt Cement Modifier

CKD can be added to asphalt binder to produce a low ductile mastic asphalt. Mastic asphalt is a mixture of asphalt binder and fine mineral material. When mastic asphalt is produced using CKD mixed 50/50 with an asphalt cement binder, a potential exists for a relatively large volume replacement of asphalt cement (between 15 and 25 percent by volume). The European use of mastic asphalts, with low ductility, for bridge deck waterproofing and protection is well documented, and this could represent a potential application for kiln dusts in the United States.[(10,11,12)]

Stabilized Base or Flowable Fill Cementitious Materials

CKD can be used as a cementitious material or a pozzolan activator in stabilized base or flowable fill applications. LKD has potential for use as a pozzolan activator in each respective application. As a cementitious material, CKD can replace or be used in combination with Portland cement. As a pozzolan activator, both CKD and LKD can replace or be used in combination with Portland cement or hydrated lime.

MATERIAL PROPERTIES

Physical Properties

CKD and LKD are fine, powdery materials of relatively uniform size. Table 8-1 lists some typical physical properties of both cement and lime kiln dusts.

Table 8-1. Typical range of physical properties of cement and lime kiln dusts.[7]

Property	Value	
	Cement Kiln Dust	**Lime Kiln Dust**
Gradation 75% passing	0.030 mm (No. 450 sieve)	0.030 mm (No. 450 sieve)
Maximum Particle Size	0.300 mm (No. 50 sieve)	2 mm (No. 10 sieve)
Specific Surface (cm^2/g)	4600 - 14,000	1300 - 10,000
Specific Gravity	2.6 - 2.8	2.6 - 3.0

Approximately 75 percent of the kiln dust particles are finer than 0.030 mm (No. 450 sieve). The fineness of kiln dust, as Portland cement, can be determined using the Blaine air permeability apparatus in accordance with ASTM C204.[13]

The maximum particle size of most CKD is about 0.30 mm (No. 50 sieve), with the Blaine fineness ranging from about 4600 (coarser) to 14000 (finer) cm^2/g.[1] LKD is generally somewhat more coarse than CKD, having a top size of about 2 mm (No. 10 sieve) and Blaine fineness ranging between about 1300 and 10000 cm^2/g. In comparison, the Blaine fineness of type Portland cement is about 3500 to 3800 cm^2/g.[14]

The specific gravity of CKD is typically in the range of 2.6 to 2.8, less than that of Portland cement (specific gravity of 3.15). LKD exhibits specific gravities ranging from 2.6 to 3.0.[1]

Chemical Properties

Chemically, CKD has a composition similar to conventional Portland cement. The principal constituents are compounds of lime, iron, silica and alumina. Table 8-2 lists typical compositions for fresh and stockpiled CKD and LKD.

The free lime content of LKD can be significantly higher than that of CKD (up to about 40 percent), with calcium and magnesium carbonates as the principal mineral constituents.

There is very little, if any, free lime or free magnesia content in stockpiled CKD and LKD that has been exposed to the environment for long periods.[1]

The pH of CKD and LKD water mixtures is typically about 12. Both materials contain significant alkalis, and consequently are considered to be caustic. Due to the caustic nature of CKD and LKD, some corrosion of metals (e.g., aluminum) that come in direct contact with CKD and LKD may occur.

Trace constituents in CKD (including certain trace metals such as cadmium, lead, and selenium, and radionuclides) are generally found in concentrations less than 0.05 percent by weight. Because some of these constituents are potentially toxic at low concentrations, it is important to assess their levels (and mobility or leachability) in CKD before considering its use.[7]

Mechanical Properties

CKD has a loose density of only about 480 kg/m^3 (30 lb/ft^3), but can be compacted to about 1350 to 1500 kg/m^3 (85 to 95 lb/ft^3) using conventional soils compaction practices.[15]

Table 8-2. Typical chemical compositions of cement kiln dust and lime kiln dust.(1)

Parameter	Cement Kiln Dust			Lime Kiln Dust		
	Fresh	Stockpiled		Fresh		Stockpiled
		Sample 1	Sample 2	High*	Low*	
CaO	40.5	31.4	44.2	54.5	31.2	31.2
Free Lime	4.4	0.0	0.0	26.4	5.1	0.0
SiO_2	14.5	11.7	11.9	9.94	2.46	1.74
Al_2O_3	4.10	3.18	3.24	4.16	0.74	0.71
MgO	1.55	0.97	1.73	0.49	23.5	23.3
Na_2O	0.44	0.13	0.27	0.03	0.00	0.05
K_2O	4.66	1.65	2.92	0.22	0.09	0.03
Fe_2O_3	2.00	2.16	1.45	1.98	0.94	1.3
SO_3	6.50	8.24	2.40	7.97	2.80	3.5
Loss On Ignition, 105°C	22.9	40.4	30.2	14.2	37.4	27.9

* Two types of lime kiln dust were classified in the reported data (high reactivity and low reactivity) on the basis of the release of heat and rise in temperature when placed in solution.

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[Asphalt Concrete] [Stabilized Base]

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Infrastructure **Materials Group**

Portland Cement

The properties of concrete depend on the quantities and qualities of its components. Because cement is the most active component of concrete and usually has the greatest unit cost, its selection and proper use are important in obtaining most economically the balance of properties desired for any particular concrete mixture.

Type I/II portland cements, which can provide adequate levels of strength and durability, are the most popular cements used by concrete producers. However, some applications require the use of other cements to provide higher levels of properties. The need for high-early strength cements in pavement repairs and the use of blended cements with aggregates susceptible to alkali-aggregate reactions are examples of such applications.

It is essential that highway engineers select the type of cement that will obtain the best performance from the concrete. This choice involves the correct knowledge of the relationship between cement and performance and, in particular, between type of cement and durability of concrete.

Portland Cement (ASTM Types)

ASTM C 150 defines portland cement as "hydraulic cement (cement that not only hardens by reacting with water but also forms a water-resistant product) produced by pulverizing clinkers consisting essentially of hydraulic calcium silicates, usually containing one or more of the forms of calcium sulfate as an inter ground addition." Clinkers are nodules (diameters, 0.2-1.0 inch [5-25 mm]) of a sintered material that is produced when a raw mixture of predetermined composition is heated to high temperature. The low cost and widespread availability of the limestone, shales, and other naturally occurring materials make portland cement one of the lowest-cost materials widely used over the last century throughout the world. Concrete becomes one of the most versatile construction materials available in the world.

The manufacture and composition of portland cements, hydration processes, and chemical and physical properties have been repeatedly studied and researched, with innumerable reports and papers written on all aspects of these properties.

Types of Portland Cement.

Different types of portland cement are manufactured to meet different physical and chemical requirements for specific purposes, such as durability and high-early strength. Eight types of cement are covered in ASTM C 150 and AASHTO M 85. These types and brief descriptions of their uses are listed in Table 2.1.

More than 92% of portland cement produced in the United States is Type I and II (or Type I/II); Type III accounts for about 3.5% of cement production (U.S. Dept. Int. 1989). Type IV cement is only available on special request, and Type V may also be difficult to obtain (less than 0.5% of production).

Although IA, IIA, and IIIA (air-entraining cements) are available as options, concrete producers prefer to use an air-entraining admixture during concrete manufacture, where they can get better control in obtaining the desired air content. However, this kind of cements can be useful under conditions in which quality control is poor, particularly when no means of measuring the air content of fresh concrete is available (ACI Comm. 225R 1985; Nat. Mat. Ad. Board 1987).

If a given type of cement is not available, comparable results can frequently be obtained by using modifications of available types. High-early strength concrete, for example, can be made by using a higher content of Type I when Type III cement is not available (Nat. Mat. Ad. Board 1987), or by using admixtures such as chemical accelerators or high-range water reducers (HRWR). The availability of portland cements will be affected for

APPENDIX F

Data Quality Report

To: Bryton Johnson - USACE, Technical Team Lead
Sarah Gettier - URS

Cc: Maryellen MacKenzie, USACE Project Manager
Pam Wehrmann – USACE, Senior Technical Chemist
April Fontaine – USACE, Technical Team Lead

From: Carleton Fong - USACE, Project Chemist

Date: January 07, 2002

Subject: Data Quality and Usability Assessment For Analytical Data Generated From The Treatability Study At SWMUs 6 and 8

A total of eight laboratory data packages were received representing the analytical data generated from the Treatability Study at SWMUs 6 and 8. The data have been reviewed to assess overall data quality and data usability as related to the data quality objectives. The following text shall be incorporated into the Treatability Study Report as a section addressing the assessment of data quality and usability. This text should be inserted prior to the section that discusses data interpretation.

Section X: Data Quality and Usability Assessment

In addition to the laboratory Level 1 and 2 data reviews, 100 percent of the analytical data was reviewed by the USACE project chemist in order to assess data quality and usability. For each analytical method, the following parameters were evaluated:

- *Sample Preservation*
- *Holding Times*
- *Instrument Calibration (as presented in the laboratory narrative)*
- *Interference Check Samples (as applicable)*
- *Serial Dilutions (as applicable)*
- *Post Spikes (as applicable)*
- *Method Blanks*
- *Laboratory Control Spikes*
- *Matrix Spikes*
- *Matrix Duplicates*

For metals analysis by Method 6010B, several sample results were estimated due to the following minor quality control (QC) deficiencies: improper sample preservation, matrix spike imprecision, low matrix spike recoveries, matrix duplicate imprecision, and positive detects in the continuing calibration blanks.

For mercury analysis by Method SW7470B and pH analysis by Method SW9045C, a few sample results were estimated due to the following minor QC deficiencies: improper temperature preservation and holding time expiration.

The QC deficiencies are considered minor and do not impact data usability. The data are considered usable for the intended purpose of evaluating the stabilization of lead during and after treatment.